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Model System To Manage Extreme States of Electrical Power Systems (7. Classification of Sequences of Accident Events in Electrical Power Generation System)

18610528 Vilnius TRUDY AKADEMII NAUK LITOVSKOY SSR: SERIYA B-KHIMIYA, TEKHNIKA, FIZICHESKAYA GEOGRAFIYA in Russian Vol 1 (170) Jan-Mar 89 (signed to press 4 Aug 87) pp 111, 119

[Excerpts from article by M. Yu. Bloznyalis and A. V. Rashkinis, Physicotechnical Problems of Power Generation Institute, Lithuanian SSR Academy of Sciences]

[Excerpts] Introduction. One important functional adviser to a dispatcher in an electrical power generation system is the subsystem that diagnoses accident processes. In response to incoming information regarding events in the system, the diagnostic subsystem must specify a class of accident states. This requires a systematic classification of all possible accident states and a mechanism for recognizing the classes derived.

Accidents may be classified from the standpoint of their cause, the type of components damaged, the structure of the process of the accident's development (chain of events), i.e., local features, or by the depth and nature of their effect on different levels of the system's hierarchy, i.e., with respect to systemwide features.

In the present work we will confine ourselves to an examination of accidents characterized by local features.

The accident classifications existing in the literature either describe anomalous states in terms that are too general (disturbance of stability, occurrence of an asynchronous course, accidents with a power deficit, etc.) or in terms that are too specific and that are confined solely to specifying the independent initial cause of the accident, for example, a short-circuit in some specific place.

Diagnosing accident processes requires classifying anomalous states examined as a result of accident events that are unfolding (i.e., anomalous states are combined into classes on the basis of the generality of the cause-and-effect links between events in analogous elements of a network) and that require a respective sequence of actions on the part of the dispatcher. As a system, the classification must reflect the structural interrelationships of the entire set of classes.

The purpose of the present work is to examine a specific mechanism that makes it possible to construct a local classification of anomalous states reflecting the structural interrelationships of an entire set of classes of accidents for the electrical power generation system examined in a previous work. [passage omitted]

Conclusions

Based on analysis of anomalous events occurring during the functioning of an electrical power generation system, the concept of a class of accidents as a sequence of an identical type of events connected by standard cause-and-effect links has been introduced.

2. A system of concepts has been developed to describe generalized accident events in a electrical power generation system and a method for formally representing them in the form of accident formulas.

3. The dependence of the complexity of the accident formulas on the level of detail with which the electrical power generation system is presented has been studied.

4. A classification tree of events has been constructed whose vertices are facts that concern the events and facilitate quick diagnosis of an anomalous state; an example of a model network of a republicwide electrical power generation system is used to depict the tree.

UDC 629.114.6(47)

AZLK-2141 Final Drive Features Discussed

18610544a Moscow AVTOMOBILNAYA PROMYSHLENNOST in Russian No 6, Jun 89 pp 11-13

[Article by A. G. Filyunov, AZLK (Moscow Motor Vehicle Works imeni Lenin Komsomol): "The AZLK-2141 Final Drive"]

[Text] Regular readers of our journal are aware that beginning in 1989 we have regularly published materials on the assemblies and units of the AZLK-2141. The following article continues this practice.

A 0.5 mm gasket is mounted between final drive and clutch housings.

As we know, the final drive increases the torque imparted to it from the gear box, and (on ATS [motor transport equipment] with longitudinally mounted engines) changes its direction. The final drive on the front-wheel driven AZLK-2141 motor vehicle is hypoidal (the axis of the drive, or pinion, gear is offset relative to the driven gear and does not intersect with it), its gears are conical with 10 teeth on the drive gear, and the driven gear is first gear.

In contrast to the classic set-up for motor transport equipment where the axis of the drive gear is offset downwards, the drive gear on 2141 and 21412 motor vehicles is offset 32 mm upwards, which allows the gear box's primary shaft to be placed above the differential housing, thus lowering the vehicle's center of gravity.

The hypoidal transmission is quite strong and operates noiselessly while being practically the same size as conically-shaped transmissions. However, because of the high degree of slippage in the area of contact of the gear teeth, it requires high-quality lubricants. In order to provide the most favorable breaking-in period and noiseless operation, the gears have been phosphate coated and impregnated with molybdenum disulfide, which allows TAD-17I (GOST 23652-77) oil to be used as a lubricant rather than hypoidal transmission oil (OST 38.01260-82), which has a high congealing temperature and is corrosive in the presence of moisture.

A special feature of the geometry of the gear toothing on the AZLK-2141 final drive compared to the gearing used on the AZLK-2140 is that the teeth, all the same height, have a great deal of curvature and are cut by the continuous indexing method and not semigenerated, which enhances their manufacturing precision, flexing strength and noiseless operation.

The final drive is joined to the clutch and the fear box and includes a gear and differential housing, the output shafts of which have flanges joining the drives to the drive wheels.

Final drive housing 52 (see Figure 1 in L. I. Smorgonskiy's article "The AZLK-2141 Motor Vehicle Gear Box"—AVTOMOBILNAYA PROMYSHLENNOST No 5, 1989), is made of cast aluminum alloy. Clutch housing 60 is mounted to the front flange by stud-bolts with self-locking nuts and housing 16 of gear box 7 is attached to the rear flange (by bolts 17).

Inside the final drive housing there is a partition with holes for mounting bearings 13 and 51 for the primary and secondary gear box shafts (the latter engages [zatselo] with the final drive pinion gear). There are also press-fittings for the reverse idler gear axle and a lubricant and pressure equalizing passage in the final drive and gear box chambers.

There are two openings in the casing's lateral walls, into which (differential) bearings 9 and nuts 4, which regulate the lateral clearance in the meshing of the final drive gears, fit. On the left side there is a lug with a threaded hole into which the speedometer drive reduction gear is screwed, and there are transmission oil drain and oil fill holes stopped with plugs 54.

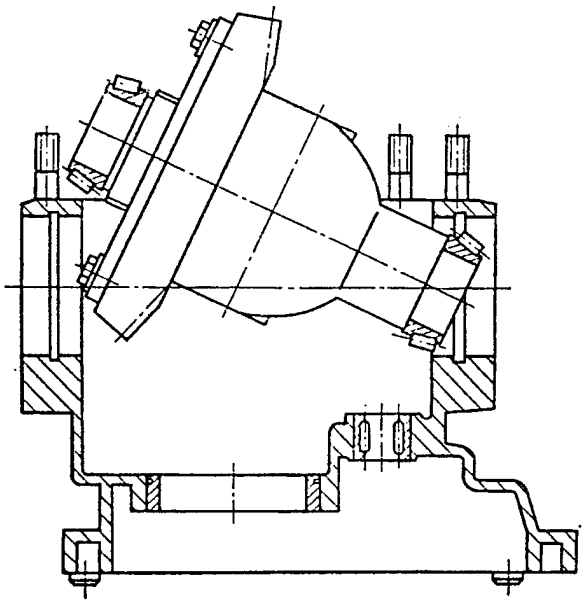
In the lower part of the interior space of the final drive casing, as viewed from the gear box, a permanent magnet has been mounted into a recess and held there by a protrusion on the casing flange to prevent it from falling out. The magnet removes wear products from the oil.

The front and rear flanges of the final drive casing are outfitted with locating pins.

Final drive pinion gear 53, which is integral with the gear box secondary shaft is mounted on two bearings. Front bearing 51 is a high-precision cylindrical gear with elongated rollers and a plastic separator. The outer bearing ring has an annular groove set in final drive casing partition 52. It is fixed by a support plate set into the groove from the axial bias. (The plate is attached to the casing by a bolt which is locked by a bend of the "feathers" of the special washer on the face of the bolt head). Rear bearing 40 is a double-race high-precision bearing with a cut inner ring and a plastic separator. When mounted its clearances remain the same in both the axial and the radial directions, which ensures that its individual parts match, and this is why the ends of this bearing may not be replaced individually when making transmission repairs. The outer ring is set in the gear box housing and held there by a collar on one side in the recess for the latter, and secured to the other side by plate 39 which is attached to the gear box casing.

The position, in the axial direction, of the drive gear relative to the ring is controlled by a set of steel regulating washers 41 mounted between driven gear 42 of the fourth gear in the gear box and the inside ring of the bearing. In order to avoid disturbing the relative position of the gears when overhauling the transmission, the inside semi-ring of the rear bearing should be marked so the gears can be reinstalled in the same position.

When it is in the requisite axial position, the pinion gear is secured by special self-locking nut 36. The cylindrical collar of the latter is compressed in three places, which is why the nut, which turns onto the threads easily at first,



progressively takes increased effort to make up and retains its axial tightness during operation.

The transmission's secondary shaft (the final drive pinion gear) has an axial duct and two radial openings in the area of the first and second gear roller bearings. An oil-separating partition is located inside the duct. The duct is covered by a washer with a hole from the face of the gear. (The partition and the washer are needed to feed the oil into the duct when the transmission is in operation, and to ensure that the oil is fed to the bearings uniformly).

Driven gear 59 of the final drive is centered on differential housing collar 5 and is attached to it by eight bolts 58 with radial incisions on the lower face of the bolt-head shoulders.

The differential housing is a one-piece unit cast of high-strength cast iron and has two openings through which the differential gears are installed. Its mechanically treated cavity is a single spherical space, which makes it possible to treat it in one pass and ensures that the relative position of the differential gears is highly accurate.

Axle 55 is secured in the housing by a tubular slit pin which is pressed into the opening in the differential housing and the axle and, in contrast to previously manufactured designs, requires no additional securing (center punching). Two conical planet pinions are mounted on the axis.

In order to get lubricants to the "planet pinion—planet pinion axle" friction pairs, the axle has eight grooves mechanically milled at a 45 angle in the area where the pairs join. The axle is phosphate-treated and impregnated with solid lubricant—molybdenum disulfide—to protect the working surfaces from scoring.

Axle shaft gears 7, which mesh with the planet pinion gears, rest on the spherical interior surface of the differential housing. The planetary pinions have ten teeth and the axle shaft gears have 16. The differential output shafts, which have flanges for attaching the housings of the interior semi-axle joints to them, are joined to the axle shaft gears by splines.

Involute gear configurations with a meshing angle of 30 to 45°, from 20 to 40 teeth and with a modulus of 1.0583 are used in the designs for the transmissions used in AZLK-2141 and AZLK-21412 motor vehicles, regardless of the number of splines.

The output shafts are centered in the inside openings of the differential housing journals and have increased-diameter neck journals, with which the working edges of glands 8 come into contact, in front of the flanges. They are prevented from axial shifting by being secured by spring retaining rings mounted in the shafts' grooves and resting in the fitted up differential in the conical groove of the semi-axle gears. (The ring must remain in its groove when the shaft is removed).

Polyamide gear 56 of the speedometer drive reduction gear is pressed onto the left (as viewed from the driven gear clamp) differential housing journal. This gear's toothing is toward the housing. The gear is held steady from axial displacement by the housing faces and the differential bearing, and from circular displacement by a cylindrical protrusion in the gear opening, which fits into the cylindrical groove on the differential housing journal. The latter, with conical bearings 9 (No 6-2007108A) pressed onto the journals, is set into recesses in the final drive housing. The bearings are tightened by adjusting nuts 4, which are prevented from unscrewing by keepers 11 secured to the final drive casing by bolts 10. These nuts maintain the necessary lateral clearance in the meshing of the final drive gears and maintain the preload of the differential bearings.

Rubber packing rings 3 are set between the outside rings of the bearings and the adjusting nuts, which prevent the oil from leaking out of the casing through the adjusting nut threads. Glands 8, which keep oil from leaking from the casing, are pressed into the adjusting nuts.

The fitted-up differential case with attached final drive driven gear, press-fitted speedometer drive and differential bearing inner rings is installed into the final drive casing cavity beginning with the journals opposite the driven gear mounting flange (see figure).

In order to ensure that the final drive operates noiselessly and to see that the form is as required and the size of the contact mark on the working surfaces of the gear teeth is in the required position, the driving and driven gears are mounted in a pair on a special control stand, and then the faces of both gears are marked with the same ordinal number. This is why the final drive gears can only be changed together.

For each pair of gears, the mounting distance from the axis of the driven gear to the front face of the driven gear, which determines their relative position, differs by some amount from the nominal distance of 53.4 mm. This distance, termed the correcting distance, is designated on the faces of both gears after their ordinal number. When the final drive is being assembled, the drive gear is installed relative to the driven gear at the nominal distance of 53.4 mm, taking the correcting distance into account. For example, if a correction of+ 0.07 is shown on the gears, adjusting washers 41 are reduced, giving a mounting distance of 53.4+ 0.07= 53.47 mm. Doing this will move the pinion gear away from the driven gear. If a correction of 0.07 is needed, a mounting distance of 53.4-0.07= 53.33 mm is provided, which increases the thickness (relative to the nominal) of the set of washers, bringing the pinion gear closer to the driven gear.

When assembling the final drive, the mounting distance is measured with measuring plates or a special-purpose micrometric stand before the differential is installed in the final drive casing with the differential bearings installed into the recess with a special mandrel.

The lateral clearance between the teeth of the pinion and the driven gears, as well as the tension of the differential bearings are regulated by nuts 4 after the pinion gear (according to the mounting distance) and the differential mechanism are installed. The lateral clearance is measured by an indicator, by placing its bar perpendicular to the lateral surface of one of the teeth of the driven gear on the outside face.

The following is the sequence for regulating the lateral clearance of the final drive gears and the preload of the differential bearings.

After the differential housing is mounted into the final drive casing, the outside rings of bearings 9 and rubber packing rings 3 are installed and adjusting nuts 4 and their pressed-in glands are made up. Then the nut as viewed from the driven gear is made up until there is no lateral clearance between the gears (the nut begins to resist being made up) and then making up the nut as viewed from the opposite side of the driven gear, the lateral clearance is set at 0.1-0.15 mm. This should make the preload of the differential bearings equal to 1.47-2.45 N m (0.15-0.25 kgs m).

The lateral clearance in any pair of gear teeth falls within 0.08-0.17 mm and should change smoothly when transferring from one tooth to another, with the difference in the clearances of the two along with the teeth set in rows should be no greater than 0.03 mm and the greatest difference in the lateral clearances (for all the teeth) of one pair of gears should not exceed 0.06 mm.

When correcting the lateral clearance the pinion gear should be locked in (the fifth gear held on the secondary shaft).

The preloading is checked for accuracy with a torque wrench, which measures the cranking torque of the gear box's primary shaft in first gear.

When the car is traveling between 5 and 7 km per hour, a slight steady noise from the final drive is allowed; knocking and grinding are not.

The final drive, which is adjusted at the manufacturing plant, usually needs no further adjusting of any sort. Such need may arise only after the motor vehicle has been operated for a long time or because of violations of the regulations concerning this unit. One indicator of the need to adjust the drive is increased noise in the unit, or an increase in the lateral clearance between the final drive gear teeth of up to 0.3 mm or more. The final drive should only be adjusted by a qualified mechanic at a technical servicing station where the proper equipment is available.

UDC 621.436:629.114.6

Use of Diesel Engines on Passenger Cars Discussed

18610544b Moscow AVTOMOBILNAYA PROMYSHLENNOST in Russian No 6, Jun 89 pp 14-15

[Article by Yu. V. Trofimenko, MADI (Moscow Highway Institute): "Diesel Engines in Passenger Cars"]

[Text] All the major motor-vehicle manufacturing firms in West Europe and Japan feature diesel-powered models in their production programs, and are producing more of these models. This is evident from the following facts: in 1986 the FRG motor vehicle industry manufactured roughly one million diesel passenger cars, which accounted for 21.7 percent of the annual production volume; since 1973 the number of these vehicles has increased 6.2-fold here relative to the overall production volume; in 1984, 44 percent of Mercedes-Benz's Series 200 and 300 motor vehicles, 39 percent of the 190 series, 31 percent of the Volkswagen Golf model, 19 percent of the Volkswagen Jetta model, 15 percent of the Opel Rekord model and 11 percent of Ford Fiestas were diesel powered.

This increased production of diesel passenger cars was caused by greater demand for them, which turned out to be somewhat unexpected by the experts since in the predictions compiled at the beginning of the 1980s, for example, it was expected that only 20 percent of the passenger cars produced in the FRG would be powered by diesel engines by the year 2000.

Meeting the demand for diesel passenger cars has been made possible thanks to the high-speed prechamber diesel engines which were converted from gasoline engines of the same size. Thus, both diesel and gasoline engines are manufactured on a single conveyer at the plant at Salzgitter (FRG). A great many interchangeable parts and assemblies are used in these engines (with diesels accounting for roughly 60 percent of the production program).

As experience in operating them has shown, prechamber diesels for passenger cars are distinguished by their high fuel economy, particularly under partial load conditions, and by the low toxicity levels of their exhaust gases. But their starting and traction-dynamic characteristics are not as good as those for gasoline engines, their noise and

vibration levels are higher (especially during warm-up), their manufacturing costs and specific mass are higher and their power to volume ratio is lower.

The same conclusion can also be drawn from the data on the table showing the indicators for the most successful designs for four-cylinder diesel and gasoline engines with displacements of up to 2,000 cm^3.

The data in the table have been corroborated by special tests. For example, in the course of these tests it was found that the Volkswagen Polo, with a mass of 800 kg and a gasoline engine and a displacement of 1,272 cm^3 and a model converted from the gasoline engine to a prechamber diesel power plant, the fuel consumption rate at speeds of 90 and 120 km/hour and in city driving came to 4.9, 6.7 and 7.7 and 4.4, 6.4 and 6.1 liters/100 km, respectively, and the times needed to accelerate from zero to 100-km/hr were 14.8 and 21.2 seconds respectively.

Thus, the consumer can choose either a car which is economical but has less torque and speed (diesel engine), or a car with improved torque dynamics, but a high fuel consumption rate (gasoline engine). Here it should be taken into account that there is no scarcity of diesel fuel abroad and it is being produced as usual, and in improved quality (Aral-Super, for example). Our country is faced with a different situation with regard to supplying diesel fuel. This is why a great many factors must be taken into account when considering converting any passenger car model to diesel operation.

In particular, the fact that the recovery levels for the oil from which diesel fuel is made has practically stabilized and the plans call for no significant increase in these levels (moreover, there is increasing demand for oil as a raw material for organic synthesis, which is becoming one of the priority consumers of the most valuable oil fractions); there are plans to greatly increase diesel truck production (to 60 percent in 1990 and 75 percent in the year 2000) and buses (40 percent in the year 2000 versus 21 percent in 1980), and this will increase the freight turnover handled by diesel motor vehicles and the passenger turnover for diesel buses in the national economy in the year 2000 by 3.8-fold and 2.8-fold respectively; the freight turnover hauled by gasoline-powered vehicles will increase by 40 percent and passenger traffic on buses with gasoline engines will show a

MANUFACTURING FIRM	DISPLACEMENT, CM^3	BORE-TO-STROKE RATIO	POWER-TO-VOLUME RATIO, kW/liter	POWER OUTPUT, kW	TORQUE, N · m	ENGINE CRANKSHAFT ROTATIONAL SPEED, min^{-1}		MINIMAL SPECIFIC EFFECTIVE FUEL CONSUMPTION RATE, GRAMS/(kW · hours)
						RATED	MINIMAL	
DIESELS								
VOLKSWAGEN	1272	1,04	25,9	33	75	4900	3000	280
VOLKSWAGEN	1471	0,96	25,2	37	82	5000	3000	271
RENO	1596	0,93	25,1	40	102	4800	2250	277
FIAT	1714	1,04	23,6	40	98,1	4500	3000	275
ISUZU	1818	0,99	24,8	45	110	4500	2000	257
PEUGEOT	1905	0,94	25,1	48	120	4600	2000	252
GASOLINE ENGINES (CARBURETTED)								
VOLKSWAGEN	1042	1,27	35,5	37	74	5900	3400	275
OPEL	1196	1,24	33,9	40	90	5600	2800	260
VOLKSWAGEN	1272	1,04	31,5	40	97	5400	3000	260
GASOLINE ENGINES (FUEL-INJECTED)								
VOLKSWAGEN	1781	0,94	46,0	82	160	6000	3500	245
VOLKSWAGEN-16U	1781	0,94	57,3	102	168	6000	4600	235
MERCEDES-BENZ M102	1997	1,11	43,6	87	178	5100	3500	244

negligible (10 percent) increase. In this regard, the demand of motor transport for diesel fuel in the year 2000 should increase significantly over 1986 while the demand for gasoline will remain at the present level or will even decline somewhat.

It must be remembered that there are plans to solve the problem of diesel-equipping motor transport equipment at this stage primarily by optimizing the quality of diesel fuel while increasing the volume of diesel fuel extracted from oil by direct distillation (increasing the distillation temperature of 50 percent of summer diesel fuel to 573 K or 300°C), and expanding and weighting the fraction portion of diesel fuel. All this will markedly lower its quality and will consequently exacerbate the problem of ensuring that diesel fuel-supply equipment operates reliably.

But there is another aspect to this problem. As research has shown, reducing the size of diesel engines and thereby the dimensions of their combustion chambers and the fuel-supply equipment worsens the conditions for organizing the working process, and where the decided-upon parameters for fuel economy for diesel-powered passenger cars will be equal or even worse than for gasoline internal-combustion engines. This is why, having analyzed the indicators for front-wheel drive passenger cars having a dry weight of from 800 to 1,050 kg (averaged data for 274 designs for European and Japanese cars of the 1985-1987 model years) with various engines (see table), specialists have come to the conclusion that at the present growth level for internal-combustion high-speed vortex unsupercharged diesel engines, it is a good idea to install them in place of gasoline engines only when the per-cylinder displacement is at least 375 cm^3.

Thus, considering our country's diesel fuel situation and the present limitations on diesel engine displacement, in the upcoming 10-12 years the number of diesel-powered passenger cars produced should not be massive. We need only meet the foreign market demand and the demand of those regions where the problem of protecting the environment from harmful discharges with exhaust gases remains acute, and the scarcity of diesel fuel is not as acute.

UDC 629.113-592.5:66.074.1

Moisture Separators for Motor Vehicle Pneumatic Systems Discussed

18610544c Moscow AVTOMOBILNAYA PROMYSHLENNOST in Russian No 6, Jun 89 pp 17-18

[Article by Candidates of Technical Sciences N. K. Dyachykov and N. N. Vishnyakov, NAMI (Central Scientific Research Institute of Automobiles and Automobile Engines): "Moisture Separators for Motor Transport Equipment Pneumatic Systems"]

[Text] Modern motor transport equipment pneumatic systems are extremely sensitive to the condensate released from compressed air which, if it is not separated, corrodes the metallic elements of these systems, washes the lubricant from the moving surfaces of the pneumatic equipment, forms ice plugs in the piping in winter and causes the pneumatic equipment valves to freeze, i.e. hinders the fitness for operation of pneumatic systems and makes motor transport equipment more hazardous to operate. To avoid this, moisture separators are used.

The most efficient of the water traps are the adsorbent type. Their active principle is based on the property of certain substances (adsorbents), which have a developed porous structure (molecular screens) to absorb moisture in the vaporous state from compressed air. Their primary advantages are reliability, simple design and small size.

Domestically manufactured motor transport equipment is equipped with these devices. Thus, NAMI specialists have developed a line of adsorbing moisture separators which use the counterflow of dried air to regenerate the adsorbent without heat. The basic design (Figure 1) includes an adsorber and a series-produced pressure regulator used on KamAZ [Kama Motor Vehicle Works] motor vehicles. To regenerate the adsorbent, a special air cylinder is attached to the air drier. The capacity of the cylinder (4,000-8,000 cm^3) is chosen based on the capacity of the pneumatic system. The adsorber consists of capsules containing an adsorbent (NaA-2KT synthetic zeolite) and distributor. The adsorbent is enclosed between two sieve plates, one of which is stationary and the second of which moves along the walls of the adsorber and is pressed against the adsorbent with a fairly strong spring. This preserves the packing density of the adsorbent as it wears.

Thanks to the simplicity of the air drier's design and also taking into account the fact that its components include a series-produced pressure regulator, it can be manufactured not only by specialized motor vehicle assembly plants, but by motor vehicle plants and even motor transport enterprises. Stand tests of the base model of the adsorbing air drier have shown it equal to similar foreign units in its effectiveness. It has a dew point margin of 288

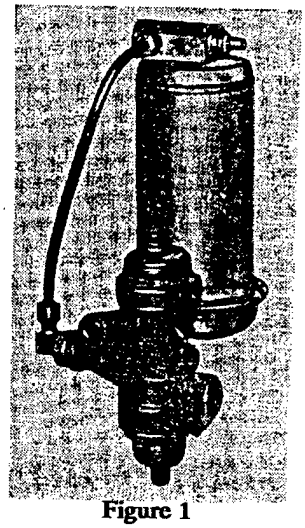


Figure 1

K (-15°C), which corresponds to 30 percent moisture in the compressed air and its fitness for duty is even better, since it can operate at temperatures lower than 233 K (-40°C). These results stem from road tests of these devices on a variety of motor transport vehicles—the KAZ-4540, KamAZ-5320, the LiAZ-5256 and others—which demonstrates its applicability to all the national economy's motor transport equipment.

One exception would perhaps be trolley-buses, on which the compressor is activated by an electric motor which is switched off when the upper pressure regulating limit is reached. A modified version has been developed which differs from the base model by a system which discharges the compressor when air stops being fed to the pneumatic system. The operating tests performed on them on ZIU-683B articulated trolley-buses confirmed the advisability of using them in the compressed air preparation system.

However, as investigations have shown, the designs which have been examined are applicable only to pneumatic system with a compressor loading factor of no more than 50 percent. Otherwise, because of the moisture separator's short-cycle operating design, the adsorbent could not be regenerated without being heated by the counterflow of dried air. This is why a third moisture separator has been developed for systems with a large compressor loading factor—a dual-adsorber model (Fig 2)—a special feature of which consists in the fact that its adsorbent is constantly regenerated while the unit is pumping. True, it is more complicated than the single adsorber model, and is much heavier and larger. This is why it should only be used on those units of motor transport equipment which, first of all, have no other option to installing it and second, which would not be greatly affected by its size and cost, BelAZ dumptrucks, for example. Especially as the experience gained from using pneumatic starting systems on BelAZ vehicles equipped with dual-adsorber moisture separators has shown that these systems are becoming more reliable and efficient. Replacing the single-adsorber air drier with the dual-adsorber unit does not complicate the vehicle's operation since both are highly standardized (as regards the adsorber and pressure regulator).

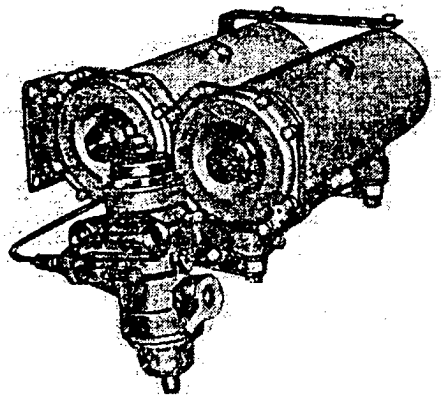


Figure 2

UDC 629.113-585-862-03:658.511.2

Metal-Saving Universal Joint Yokes Discussed

18610544d Moscow AVTOMOBILNAYA PROMYSHLENNOST in Russian No 6, Jun 89 pp 17-18

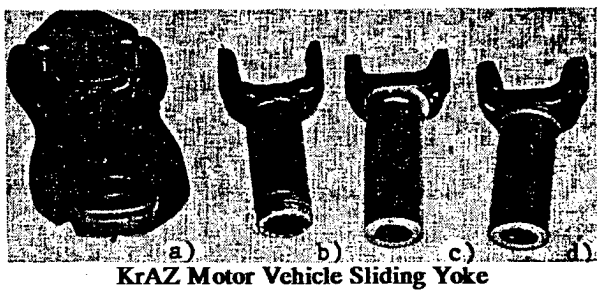
[Article by A. F. Vavilov and I. D. Mysnikova, KTIAM: "Metal-Saving Universal Joint Yokes"]

[Text] When machining motor vehicle parts whose blanks are forged parts with complicated shapes, a great deal of metal is lost as flash, chips and so on. Thus, when sliding universal joint yokes are being manufactured, the amount of metal lost (in flash and waste) in hot die forging amounts to 25 percent of the mass of the initial blanks and during machining of the forged parts, over 50 percent of the metal ends up as chips (there is usually more waste for forged parts with internal splines than for those with exterior splines). As a result, the amount of metal used per unit, and consequently the cost of these parts, turns out to be unjustifiably high.

The manufacturing methods and equipment developed by KTIAM [possibly Kiev Technological Institute of Motor Vehicle Machine Building] specialists and introduced in a number of the sector's plants have brought about significant reductions in metal consumption (21-24 percent, and 31-41 percent of waste metal and chips).

The manufacturing methods call for making a yoke out of two parts joined by friction welding (see picture), i.e., a hot forged yoke with a more simple shape and a tubular blank. For yokes with internal splines, the yoke blank is cut from a tube of the correct cross section and for yokes with external splines, a stepped bushing is manufactured of reduced or expanded tubing, which reduces the allowance for machining. The materials for the blank are selected so as to produce yokes whose parts are equally durable.

Preparing the bushings for welding is usually limited by undercutting the welded face; the amount of machining needed when preparing the yokes for welding depends on specific production conditions. Thus, if the transition from the traditional method of manufacturing these parts (from forged parts) to the new method, whereby an



KrAZ Motor Vehicle Sliding Yoke

Key: a) Forging (with flash); b) Workpiece finished from forging; c) Friction welding blanks; d) Drop-forge-welding blank

attempt is made to maximally reduce the existing equipment on flow-type machining production lines, preparation is reduced to the minimum: The welded face is undercut and the datum (cylindrical) surface is turned (this method is used at the Grodno Cardan Shaft Plant imeni 50th Anniversary of the USSR and the Ulyanovsk Motor Vehicle Works); if the amount of machining performed after welding needs to be reduced, both the welded area on the yoke and its lugs are machined (grinding, drilling), with small allowances for final machining, which significantly reduces the mass of the die-forged blanks (this method is used at the Kherson Cardan Shaft Plant imeni XXV CPSU Congress).

Friction welding can also be performed during finishing operations, but only providing there is no requirement for accurate angular positioning of the splines relative to the axis of the openings in the lugs. Both KamAZ and ZIL use this production method.

The experience gained at a number of motor vehicle plants shows that the quality of the forged yoke parts (primarily the degree to which they correspond to the drawings) depends in large part on the quality of the blanks and the reliability of the clamping device on the friction welding machine, and these conditions are met if the same datum surfaces are used for the clamping devices both when the blanks are being prepared and when they are being friction welded.

The bushings are usually mounted in the welding machine's rotating clamping device. As found when testing a variety of clamping device designs, collet chucks provide the best results from the standpoint of securing the workpieces accurately and reliably.

The choice blank-clamping devices depends on the method used to set up this workpiece for welding. But in any case, the blank must be self-centered when being secured.

In order to increase the productivity of the welding machine and the reliability with which its clamping devices secure the blanks regardless of their design, the welding machine should be equipped with a hydraulic drive.

The choice of a type of welding machine is made based on the basic parameters of the regime—the heating and forging forces—which in turn depend on the area of the joint and the material of which the blanks being welded are made (see table).

In friction welding, in accordance with the usual (two-step) cycle of changing pressure, the clamping devices and drive coupling take on considerable loads. This is caused by the "peaks" in the frictional torque on the joint being welded. These peaks can be observed at the beginning of the heating and during the transitional stage from heating to forging. This can fracture the working surfaces of the clamping devices (for circular workpieces) and can cause the drive couplings to break down. To avoid this, KTIAM specialists changed the manufacturing method somewhat, increasing

Indicator	Sliding Yoke				
	210-2201048 (KrAZ)	500A-2201048 (MAZ)	53A-2201048 (GAZ)	469-2201048 (UAZ)	5320-3422034 (KamAZ)
Characteristics of welded blanks					
Steel	40	40	40	40X	45
Outside diameter of spline, mm	83	85	56	56	45
Area of joint cross-section, mm²	3,370	3,940	1,560	1,560	628
Welding machines and their operating conditions					
Friction-welding machine	PST-50-2	PST-50-2	PST-50-2	PST-25-2	PST-10M2
Rotational speed of spindle, min⁻¹	1,000	1,000	1,000	1,000	2,000
Forces, kN:					
lapping	Increases smoothly to heating force				
heating	170	200	100	100	40
forging	340	400	200	200	80
Time, in seconds:					
lapping*	3—4	3—4	2.5—3	2.5—3	1.5
delay for switching machine on	1.5	1.5	1.5	1.5	1
heating (minimum)	8	8	5	5	1.8
heating (maximum)	20	20	16	16	10
joint braking	0.3	0.3	0.3	0.3	0.3
delay	0.7	0.7	0.5	0.5	0.4
forging	2	2	2	2	1.5
Setting, mm:					
heat**	3.5—4	3.5—4	3	3	3
minimum total (after forging)	6m	6	5.5	5.5	5.5

*—duration of lapping depends on setting-up of lapping mechanism
**—setting is determined by setting-up of its control mechanism

the heating smoothly and beginning the forging operation only when the spindle has stopped.

Moreover, the control system for the welding machine can regulate the degree to which the joint being welded is heated according to the amount of setting in the joint, and can monitor the minimum and maximum heating time as well as the basic welding parameters: heating and forging pressures and the total setting in the joint after welding. And operating experience has shown these systems to be sufficiently reliable, which rules out the possibility of producing finished items with defective joints caused by disruptions in the welding regime parameters as well as by local incomplete fusion in the joint when welding blanks with significant dimensional deviations. This is why specialists from a number of plants, after heat-treating Cardan shafts, have to perform additional monitoring of welded joints by loading them with a flexing force, or via the non-contact electromagnetoacoustic method. This monitoring can be performed immediately after welding or after heat-treating. The former is preferable since monitoring takes less time than welding and the welder-operator can perform the check.

The steel used to make sliding yokes is self-hardening. This means that the area of the joint acquires greater hardness as it cools in the air, which consequently makes it more difficult to machine with a cutting tool. This is why, when necessary, these workpieces are subjected to some form of heat-treating after welding: usually quenching or hardening with high temperature. The type of heat-treatment is chosen depending on specific conditions of the production setup and the availability of

heat-treating equipment, and is based on the need to cut labor and time inputs for this operation. From this point of view, quenching (high-temperature hardening) of the blanks is preferred prior to welding and normalizing the welded joint by heating it with TVCh [high-frequency current]: the necessary structure is obtained for the metal in the area of the joint, and with negligible electric power outlays and transport expenditures.

Where no TVCh equipment is available, the high-temperature hardening (quenching) is performed after welding rather than before. This manufacturing procedure consumes much less electric power (fuel) for heat-treating.

Long-standing experience in manufacturing universal joint yokes from forged blanks convinces one that the new manufacturing methods have significant advantages over traditional methods: the new procedure has reduced the need for rolled steel stock by 25-30 percent; fuel and electric power consumption for hot-forging operations, heat-treatment and machining as well as the costs for dies and metal-cutting tools have been drastically cut. Moreover, the efficiency of the process has been enhanced. Calculations indicate that the transition to the forge-welding alternative for manufacturing the entire produce array of yokes (over 20 designations) cuts the sector's metal consumption by 8,000 tons per year. But the fact is that this process can also be used to manufacture many other motor vehicle parts with complex or stepped shapes.

UDC 621.822-033.7

Ceramic Bearing Parts Discussed

18610544e Moscow AVTOMOBILNAYA PROMYSHLENNOST in Russian No 6, Jun 89 p 28

[Article by Candidates of Technical Sciences B. Yu. Dorofeyev, V. P. Lukyanov, and A. N. Atras, of the NPO VNIPP (Scientific Production Association of the All-Union Scientific Research, Design and Technological Institute of the Bearing Industry), and the Moscow Institute of Fine Chemical Technology imeni M. V. Lomonosov, under the "Answers to Readers' Letters" rubric: "Ceramics in Bearings"]

[Text] "Overseas, as we know from newspapers and magazines, ceramic materials are being increasingly used in the manufacture of engine parts, bearings and other machine-building products," writes reader V. S. Frolov from the city of Lyubertsy. "I would like to find out how this line of inquiry is developing in our country. Are we conducting research in this area? Are there any prospects?"

The following article may provide some answers to the letters sent to us.

The potentialities of nickel- and cobalt-based hot-strength metallic materials for raising their working temperatures have practically been exhausted. This is why researchers involved in developing mateirals, particularly for roller bearings which work at temperatures of 1,573-1,673 K (1,300-1,400°C), are searching for new materials. Recently, they have been placing increasing emphasis on silicon nitride compositions.

This emphasis is certainly not accidental. Even though silicon nitride is typically a brittle material which displays no macroscopic plasticity when fractured in a broad range of temperatures. It has been found that the content and nature of macro- and microdefects, the type of stress state and the deformation rate greatly influence the strength of this material, and its breaking point is determined by special features of the generation and distribution of brittle cracks.

Thus, silicon nitride-based materials lose very little of their strength up to temperatures of 1,273-1,473 K (1,000-1,200°C). Raising the temperature further can even make them stronger by increasing their surface energy and reducing the critical size of the cracks by "dulling" the sharp cracks and certain other phenomena. It has also been established that the primary factor which improves the high-temperature strength and reduces the low-temperature crack resistance of silicon nitride-based composition materials is its fine-grained structure, which is determined by and large by the initial size of the particles of powder mateirals, and which is "inherited" by the finished product.

But it is no simple matter to attain the necessary fine-grained structure. The point is that silicon nitride powders are now commonly produced for powder metallurgy in many variations by the direct synthesis method, the thermal dissociation method, the method by which it is precipitated from the gas phase as well as by mechanical milling (an optional type of processing). Here, the materials being blended are the composition's components which are usually mixed together and ground in attrition mills, where the powders are not only ground up, but are mechanically alloyed with particles of aluminum oxide, magnesium etc. In addition, the grinding tools themselves create wear particles and the attrition mill housing generates dust which gets into the mixture, thus lowering the strength of its base material.

Specialists from the VNIPP NPO and MITKhT [Moscow Institute of Fine Chemical Technology imeni M. V. Lomonosov] have suggested another method for grinding silicon nitride—an eddy mill. In this unit, the powder is mechanically annealed while being ground (industrial nitrogen is used as an energy resource). The specialists feel that this grinding method enhances the fracture-resistance and high-temperature flexural strength of the hot-forged composition and lowers the forging temperature.

These predictions have been confirmed.

Actually, the matrix phase (β-phase content of 20-30 percent) of the compositions produced by the new method consists primarily of polyhedral crystals of 0.5-1.5 mcm (previous compositions, treated by the usual method in attrition mills consist of oblong prismatic crystals 1-8 mcm in size). The number of micropores (2-4 mcm) in them are 5-6-fold and the number of submicropores (0.1-1 mcm) 15-20-fold fewer than when ground in

attrition mills; the micropores are almost spherical, i.e., the stress state and the structure of the particles created in the initial blend are conducive to strengthened products.

Interest has also been shown in the results of research aimed at changing the strength parameters of the produced compositions depending the kinetics of hot pressing, or extrusion.

The silicon nitride β-phase formed during treatment in the eddy mill grows much quicker than when ground in the attrition mill. As its concentration increases, the morphology of the granule boundaries changes: the initial equilibrate structure of the silicon nitride after a brief period of packing contains a small amount of elongated granules. Holding the charge under a pressure of 80 MPa (0.8 ton-forces/cm^3). Following the complete transition from the α-phase to the β-phase causes an increase in the mean diameter of the polyhedral and prismatic granules of the latter (by 20-30 percent) and lowers its strength.

There is, however, a paucity of information regarding the strength indicators for brittle mateirals as regards the considerable influence of defects. In this regard, the resistance of friable cracks to spreading, which is more relevant to bearing mateirals and also more significant when the contact endurance is not tested, can also be used as an indirect indicator of contact strength. If the coefficient of resistance to the spreading of brittle fractures is within permissible limits, the ceramic material can be used in the manufacture of parts which bear alternating contact loads and their use can be guaranteed, since a high coefficient means an almost complete absence of pores, which contribute to the generation of critical cracks.

When the method under discussion is used at relatively low temperatures and when the pressure is not held for a long period of time, an acceptable level for this coefficient can be obtained, which indirectly confirms the possibility for using the blend developed by the suggested method to manufacture parts which will work under contact load conditions. In this case, the coefficient can be raised by creating (via preliminary treatment in an eddy mill) residual stresses in the blended materials which are then "inherited" by the hot pressed structure but which are concentrated by and large, around the carbide and oxide inclusions. During the cooling period after hot pressing, radial expanding and tangential compression stresses appear in the silicon nitride matrix. When the blend has bene treated beforehand in an eddy mill, these stresses are fairly great.

Thanks to this, the movement front of the cracks expands, and the coefficient becomes higher.

Thus, it has been established by research that treating silicon nitride initial blend compositions in an eddy mill under definite regimes significantly (by 15-20 percent) increases the hot flexure strength of the materials, and increases their crack resistance by 10-20 percent, which allows this method to be recommended when producing ceramic materials to be used in the manufacture of roller bearing parts.

UDC 539.3

Designing Cylindrical Shell Immersed in Fluid With Constraints on Strength and Natural Vibration Frequency

18610565a IZVESTIYA AKADEMII NAUK ARMYANSKOY SSR: SERIYA MEKHANIKA in Russian No 5, Sep-Oct 88 pp 3-7

[Article by V. Ts. Gnuni and R. S. Kazaryan]

[Text] Let there be a closed cylindrical shell with the dimensions l, R, and h that has been manufactured from monolayers of an orthotropic composite and that has been laid out at angles of plus or minus φ to the shell's axis. The shell, which is immersed in fluid, is subject to the fluid pressure q on all sides.

The problem is to design a shell with the maximum weight given the specified external pressure levels q, the first natural vibration frequency approximately Ω, and a constraint on its strength.

1. In a previously published work,[1] to determine the thickness of a shell made of a composite that was immersed in fluid given specified natural vibration frequency values of

$$\tilde{\Omega}=\tilde{\Omega}_{mn}(m, n, q) \tag{1.1}$$

and that had an external omnilateral fluid pressure of q, the following equation was derived:

$$h_{mn}^3-B_{mn}h_{mn}-C_{mn}=0 \tag{1.2}$$

The following designations have been introduced here:

$$B_{mn}=\frac{\tilde{\Omega}_{mn}^2-\frac{B_{11}^0 m^4}{\rho R^2}[\bar{a}_{11}m^4+(\bar{a}_{66}-2\bar{a}_{12})m^2\bar{n}^2+a_{22}\bar{n}^4]^{-1}}{\frac{B_{11}^0 X^4}{12\rho R^4}[\bar{D}_{11}m^4+2(\bar{D}_{12}+2\bar{D}_{66})m^2\bar{n}+\bar{D}_{22}\bar{n}^4]} \tag{1.3}$$

$$C_{mn}=\frac{\frac{\rho_0 R}{\rho\chi}\bar{\Omega}2_{mn}K_{mn}+(0,5m^2+\bar{n}^2)\frac{q\chi^2}{\rho R}}{\frac{B_{11}^0\chi^4}{12\rho R^4}[\bar{D}_{11}m^4+2(\bar{D}_{12}+2\bar{D}_{66})m^2\bar{n}^2+\bar{D}_{22}\bar{n}^4]}$$

$$\bar{a}_{ik}=B_{11}^0 h a_{ik},\ \bar{D}_{ik}=\frac{12}{B_{11}^0 h^3}D_{ik},\ \chi=\frac{\pi R}{l},\ \bar{n}=\frac{l}{\pi R}n$$

$$K_{mn}\frac{K_0(\chi\sqrt{m^2+\bar{n}^2})}{\sqrt{m^2+\bar{n}^2}\cdot K_1(\chi\sqrt{m^2+n^2})}$$

where K_0 and K_1 are modified Bessel functions, m is the number of the half-waves along the generatrix, n is the number of waves along the circumference, ρ is the density of the shell's material, and ρ_0 is the density of the fluid.

As in the aforementioned earlier work,[1] equation (1.2) has been derived for a cylindrical shell segment that is hinged along its faces to rigid frames.

It follows from (1.1) and (1.2) that the calculated thickness providing the specified value of the first natural vibration frequency approximately Ω, given a fixed level of external omnilateral fluid pressure q, is determined from the condition

$$h_1=\max_{m,n}h_{mn}(m,\ n,\ q,\ \tilde{\Omega}) \tag{1.4}$$

where h_{mn} is the single real positive root of equation (1.2).

It is obvious that ensuring the design's serviceability also requires satisfying strength constraints.

Let the momentless stressed state with the following forces be implemented (approximated) under the effect of the external omnilateral pressure in the shell:

$$T_{xx}=C_{11}\epsilon_{xx}+C_{12}\epsilon_{yy}=\frac{1}{2}Rq,\ T_{yy}=C_{12}\epsilon_{xx}+C_{22}\epsilon_{yy}=Rq,$$
$$T_{xy}=C_{66}\epsilon_{xy}=0 \tag{1.5}$$

where

$$\chi\in[0,l],\ y\in[0,2\pi R].$$

Hence, the following is derived for the deformations in the main geometric directions:

$$\epsilon_{xx}=\frac{0.5B_{22}-B_{12}Rq}{B_{11}B_{22}-B_{12}^2\ h},\ \epsilon_{yy}=\frac{B_{11}-0.5B_{12}}{B_{11}B_{22}-B_{12}^2}\frac{Rq}{h},\ \epsilon_{xy=0} \tag{1.6}$$

The stresses in the main geometric directions are determined by the formulas

$$\sigma_{xx}=B_{11}\epsilon_{xx}+B_{12}\epsilon_{yy}=\frac{Rq}{2h},\ \sigma_{yy}=B_{12}\epsilon_{xx}+B_{22}\epsilon_{yy}=\frac{Rq}{h}$$
$$\sigma_{xy}=B_{16}\epsilon_{xx}+B_{26}\epsilon_{vy}=L\frac{Rq}{h} \tag{1.7}$$

where

$$L=\frac{B_{16}(0,5B_{22}-B_{12})+B_{26}(B_{11}-0,5B_{12})}{B_{11}B_{22}-B_{12}^2}$$

Here it is necessary to state that, despite the orthotropicity of the shell as a package with respect to its thickness overall, monolayers in the main geometric directions are anisotropic

$$B_{i6}(\varphi)=-B_{i6}(-\varphi)$$

The coefficients $B_{ik}(\varphi)$ are determined through the monolayer's elasticity coefficients by using turning formulas.[2]

The stresses in the shell's monolayers in the direction in which they were laid (in the main physical directions) are determined by the following formulas:

$$\sigma_{11}=(0,5\cos^2\varphi+\sin^2\varphi+L\sin 2\varphi)\frac{Rq}{h},$$
$$\sigma_{22}=(0,5\sin^2\varphi+\cos^2\varphi-L\sin 2\varphi)\frac{Rq}{h} \tag{1.8}$$
$$\sigma_{12}=(0,25\sin 2\varphi+L\cos 2\varphi)\frac{Rq}{h}$$

Formulas (1.5) through (1.8) have been derived given the boundary conditions

$$v=0,\ T_{11}=\frac{Rq}{2}\ (x=0,\ x=1)$$

where v is the tangential movement in an annular direction.

From the condition of the monolayer's strength,[3,4]

$$\frac{\sigma_{11}^2}{\sigma_{B1}^2}+\frac{\sigma_{22}^2}{\sigma_{B2}^2}-\frac{\sigma_{11}\sigma_{22}}{\sigma_{B1}^2}+\frac{\sigma_{12}^2}{\tau_{BO}^2}=1 \qquad (1.9)$$

the following is derived for the calculated thickness h_2:

$$h_2=Rq\sqrt{F(\varphi)}$$

where (1.10)

$$F(\varphi)=\frac{1}{\sigma_{B1}^2}(0,5\cos^2\varphi+\sin^2\varphi+L\sin2\varphi)(2L\sin2\varphi)-0,5\cos2\varphi)+$$
$$+\frac{1}{\sigma_{B2}^2}(0,5\sin^2\varphi+\cos^2\varphi)-L\sin2\varphi)^2+$$
$$\frac{1}{\tau_{BO}^2}(0,25\sin2\varphi+L\cos\varphi)^2 \qquad (1.11)$$

2. Before proceeding to the task of designing the shell, we must provide the following explanation.

In real designs, a shell segment is generally fastened to face frames, and the calculated thicknesses should be

$$h_1=\alpha h_1,\ (\alpha<1);\ h_2=\beta h_2,\ (\beta>1) \qquad (2.1)$$

The coefficient $\alpha<1$ allows for the deviation in boundary conditions under which formula (1.4) was derived from actual conditions, whereas the coefficient $\beta>1$ provides a correction allowing for the boundary effect. However, in view of the fact that determining and selecting the coefficients α and β are not problems for the present article and do not affect the algorithm used to solve the problem, the numerical realization has been conducted for the case where $\alpha=\beta=1$.

The following problem of designing an optimum shell made of composite has been formulated.

Given specified q and approximately Ω, find the angle of laying the monolayers φ such that

$$max[h_1(q,\tilde{\Omega},\varphi);\ h_2(q,\varphi)]\rightarrow min \qquad (2.2)$$

where

$$\varphi\in[0^\circ,90^\circ].$$

As an example, we will examine the example of designing a closed round cylindrical shell manufactured of monolayers of an orthotropic composite with the characteristics

$$\overline{\beta}_{22}^0=0,1,\ \overline{\beta}_{12}^0=0,030,\ \overline{\beta}_{66}^0=0,033,\ \overline{\sigma}_{B1}=0.007,$$
$$\overline{\sigma}_{b2}=0,004,\ \overline{\tau}_{BO}=0,0006,\ \rho/\rho_o=1,99$$

given the following geometric parameters: $\pi R/l = 2$ *and* R = 150*cm*.

Given these data, Table 1 presents the values of the smallest calculated thickness h in centimeters and the respective optimum angles φ for the specified values of q that are the least with respect to m, n, and approximately Ω and the immersion levels q.

Table 1

q/Ω	100	200	300	400	500
1 MPa	2.04[1]	2.55	3.13	3.74	4.41
	80[2]	58	45	40	35
2 MPa	2.80	3.10	3.56	4.32	4.73
	86	84	45	45	35
5 MPa	4.20	4.35	4.65	4.95	5.49
	37	33	39	40	35
10 MPa	7.99	7.99	7.99	7.99	7.99
	35	35	35	35	35

1. h=2.04; 2. ϕ=80°

It should be noted that when q= 10 MPa or more, the strength constraint is active, and the constraint on the first natural vibration frequencies up to Ω = 500 Hz results in lower thickness values. In this case, the angle φ = 35° is optimum, and the calculated thickness is as follows:

$$h=minh_2(\varphi)$$

When approximately Ω = 500 Hz, the optimum angle φ = 35° provides the smallest thickness with respect to both strength and dynamic criteria.

Figure 1 presents graphs of

$$h_1(\varphi)=\max_{m,n}h_{m,n}(\varphi,q,\tilde{\Omega})\ and\ h_2(\varphi)=$$
$$=Rq\sqrt{F(\varphi)}$$

as functions of the angle at which the monolayers of composite are laid φ when approximately Ω = 100 Hz for different q. The solid lines correspond to $h_2(\phi)$, and the dashed lines correspond to $h_1(\phi)$ for the intensity values of the external even pressures q_1= 1 MPa, q_2

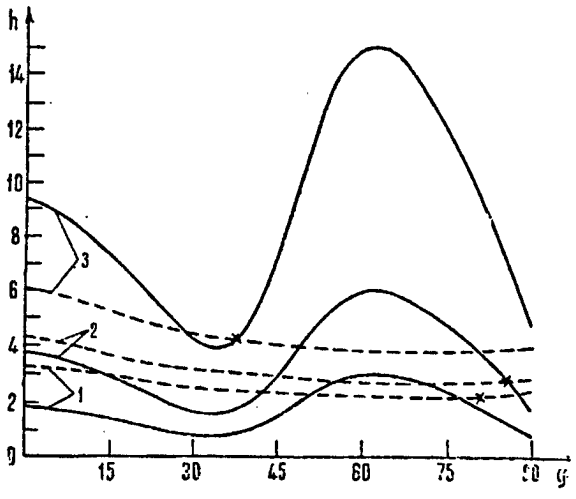


Figure 1

=2 MPa, and q_s=5 MPa. The x's indicate the respective optimum points. As is evident from Figure 1, $h_i(\phi)$ changes over a rather wide range, and the need for the optimum selection of the angle ϕ and the benefits of optimization are obvious.

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UDC 532.135

Temperature Distribution in Half-Plane of Viscoelastic Material During Vibration of Rigid Die at Boundary

18610565b IZVESTIYA AKADEMII NAUK ARMYANSKOY SSR: SERIYA MEKHANIKA in Russian No 5, Sep-Oct 88 (signed to press 18 Jun 85) p 53

[Abstract of monograph "Temperature Distribution in Half-Plane of Viscoelastic Material During Vibration of Rigid Die at Boundary," by G. B. Vermishyan, deposited in All-Union Institute of Scientific and Technical Information under No 8891-V 87 on 17 December 1987]

[Text] This monograph examines the temperature distribution in a half-plane of viscoelastic material while a distributed load that changes in accordance with a harmonic law and whose amplitude has a constant intensity acts upon a portion of its boundary. Also examined is the case where a rigid die that has a vibration load with a constant amplitude is applied to a portion of the boundary while the remaining portion is free from any impressed loads. For the case of a distributed load, the temperature at the boundary of the half-plane is assumed to be constant and equal to that of the environment. It is also assumed that, during the action of the rigid die, the section of the half-plane boundary where the die is applied is heat insulated and that free heat release to the environment occurs outside the die.

UDC 539.376

Designing Cylindrical Shells Under Conditions of Unsteady Creep

18610565e IZVESTIYA AKADEMII NAUK ARMYANSKOY SSR: SERIYA MEKHANIKA in Russian No 5, Sep-Oct 88 (signed to press 11 Apr 1986) p 56

[Abstract of monograph "Designing Cylindrical Shells Under Conditions of Unsteady Creep," by Yu. M. Sevdimaliyev, deposited in All-Union Information of Scientific and Technical Information under No 436-V on 19 December 1987]

[Text] This article examines the problem of the stability of a cylindrical shell under the effect of external pressure. A mixed variation principle proposed for creep problems is effective from the problem's numerical implementation. It is hypothesized that the buckling during creep occurs "with a bang" in accordance with an elastic deformation mode. The effects of the degree of nonlinearity of the instantaneous deformations and the degree to which the creep deformations are reinforced on the critical buckling time over a wide range of variation in the initial imperfections are established. The spectrum of the dependence of the buckling process on the shell's physical and geometric parameters are compared with existing solutions.

UDC 539.376+ 539.32

Two-Phase Rheological Model

18610565c IZVESTIYA AKADEMII NAUK ARMYANSKOY SSR: SERIYA MEKHANIKA in Russian No 5, Sep-Oct 88 (signed to press 18 Feb 1985) p 54

[Abstract of monograph "Two-Phase Rheological Model," by A. A. Zevin, deposited in All-Union Institute of Scientific and Technical Information under No 8889-V 87 on 17 December 1987]

[Text] This article presents a rheological model that is used as the basis for constructing a nonlinear theory of creep of both nonaging and aging materials along with relationships considering the effect of temperature on creep deformation.

The nonlinear theory reflects a number of qualitative effects observed during experiments (the partial irreversibility of creep deformation, the linear dependence of reverse creep on the load history, etc.), and from a quantitative standpoint, it corresponds well with experimental data obtained during variable loads.

The determinant relationships allowing for the effect of temperature also reflect a number of effects that are observable in experiments: a sharp increase in the creep

rate during a gradual increase in temperature; the dependence of the threshold deformation on temperature; the irreversibility of a portion of the linear creep deformation, provided the loading was done at an elevated temperature; and the return of residual deformation when the temperature is increased after the load is removed; etc.

UDC 539.3

Theory of Application of Large Deformations in Bodies Made of Incompressible Elastic or Viscoelastic Material

18610565d IZVESTIYA AKADEMII NAUK ARMYANSKOY SSR: SERIYA MEKHANIKA in Russian No 5, Sep-Oct 88 (signed to press 1 Apr 1986) p 55

[Abstract of monograph "Theory of Application of Large Deformations in Bodies Made of Incompressible Elastic or Viscoelastic Material," by V. A. Levin, deposited in All-Union Information of Scientific and Technical Information under No 8890-V 87 on 17 December 1987]

[Text] The principal relationships of the theory of the application of large deformations for bodies made of incompressible elastic or viscoelastic material are presented. The problem of the formation of holes in a prestressed body that are round at the moment when they are formed is solved. Methods involving numerical and analytical computations on a computer that are based on the sequential approximations method, Laplace transforms, and the Kolosov-Muskhelishvili method are used in solving the problem.

UDC 539.01

Constructing Green Tensor for Certain Problems for Elastic Parallelepiped

18610565f IZVESTIYA AKADEMII NAUK ARMYANSKOY SSR: SERIYA MEKHANIKA in Russian No 5, Sep-Oct 88 (signed to press 24 Sep 1984) p 57

[Abstract of monograph "Constructing Green Tensor for Certain Problems for Elastic Parallelepiped," by V. D. Sheremet, deposited in All-Union Information of Scientific and Technical Information under No 2409-V 88 on 29 March 1988]

[Text] Exact Green motion effect tensors for an elastic parallelepiped at whose boundaries two types of boundary conditions are specified are proposed for the first time. The two types of boundary conditions are as follows: 1) normal stresses and tangential movements and 2) normal movements and tangential stresses. Besides their independent significant for solving these two types of boundary value problems, the proposed Green tensors may serve as nuclei when using the method of boundary integral equations to solve basic elasticity theory problems for a parallelepiped, in particular a Lame problem.

An exact solution of the problem of the thermoelastic compression of a parallelepiped without surface friction is presented on the basis of the Green tensors constructed.

Defense Industry Manages Durable Consumer Goods Enterprises

18610386 Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 12 Mar 89 p 2

[Article by Ye. Chernova: "'Oboronka' [Defense Industry] Changes Its Vocation"; first paragraph is SOTSIALISTICHESKAYA INDUSTRIYA introduction]

[Text] More than a year ago the entire branch, the Ministry of Machine Building for Light and Food Industry and Household Appliances [Minlegpishchemash] was disbanded. It was the most backward, indigent and consumer- and newspaper-beaten branch. Its enterprises were given into powerful hands of defense industry Ministries. And what is the result? Has this unprecedented symbiosis been working?

Cost Accounting and Disarmament

Before answering this question, one must make a slight digression.

It is well known that in capitalistic countries, particularly in such a large manufacturer of military hardware as the United States, there is no division into civil and military sectors—their national economy is an indivisible organism. Nevertheless, "they" too have the need to use the results of defense-related work for non-military applications.

The logic here is quite simple. Discoveries and inventions made while fulfilling defense orders, when adapted to the civil industry, make a technological revolution. This improves the competitiveness of American goods in world markets, thus increasing the wealth and world influence of the American state. Therefore, huge sums of money invested annually into military-related research and development, are being recouped, even if only partially.

Hence the entire set of measures employed by the state to facilitate technology spin-offs, such as improving national information service, a flexible patent policy, special items in contracts etc. And what about results? Here are but a few achievements: a method for improving the durability of welded joints, ultrasonic welding, precision material working and a method for storing cryogenic liquids. They all have been transferred from defense to industry. This is also true for CNC machine-tools, integrated circuits and semiconductors. According to NASA's data, the space program alone has contributed $35 billion to the American economy. American media reported that in the mid 70's the overall cost of new technologies, machines and devices that had found their way to non-military applications totalled $27-30 billion.

And what about us? We published Y. Valkov's, Chief Designer of a defense industry plant, viewpoint ("Last Trump Card", SOTSIALISTICHESKAYA INDUSTRIYA, 13 Nov 88), who called the conversion the last trump card of our economy. Not everybody agrees. Be it as it may, our defense industry, although its structure is fundamentally different, can make a tremendous contribution. The defense industry itself needs this.

The first spin-off exhibition took place at the Minobshchemash's [USSR Ministry of General Machine Building] TsNIITM [Central Scientific Research Institute of Machine Building Technology]. One had the impression that technologies from two different worlds had met.

For example, a new dough trough was demonstrated. There was no need to show the old trough - one can see it in any bakery. It is heavy, with poorly cleaned welds (bakers know that dough particles stick to such welds, rot and spoil the entire batch), and worst of all, it is made of aluminum. The new trough is ideally smooth, because it was built using different technology—rotational expansion of a flat steel billet. This technology reduces labor cost by 75-85 percent and material cost by a third. The old Minlegpishchemash could not even have dreamt of this.

There are many examples of revolutionary technological changes. TsNIITM, which played an active role in the development of "Energiya" [not further identified], has the country's best level of welding technology. They have got everything: beam, diffusion and pulse welding, with a high degree of automation. What a contrast with Minlegpishchemash enterprises! And what about casting? They use thin-wall casting of non-ferrous metals, investment casting with directional crystallization, etc.

Here are two industrial worlds that were forcefully separated and have been developing according to different laws. The wealth of the first one has grown largely at the expense of the other. And now empty store shelves and the system of rationing basic food products essentially render all these unthinkable achievements of "closed" and "classified" industries useless to our people.

"Before, we would have been shocked if someone had come up with an idea to give us this work. Just imagine: us and some cutters for meat-packing plants! And now these backward plants are a godsend", says Candidate of Technical Sciences V. Isachenko, the Institute Director. "I think, the very progress and achievements of our enterprises depend on constant heavy work load and on changing goals. Should the work load decrease, it would lead to degradation of our collectives. And now the situation is different. We do feel the disarmament. Our production volume will probably decrease. Understanding that, most of Minobshchemash plants took on manufacturing of Minlegpishchemash products. Add to this the cost accounting. For example, just to maintain last year's level, the Institute must increase its production volume by 20-30 percent. Where would I have gotten it?"

Export of Principle

For quite a while I could not hear words like "we will be", "we are taking it upon ourselves", and "we will achieve" without considerable scepticism. And in this case I did not believe them either. How many times have we put

hope in all kinds of "breakthroughs", when we were mechanically trying to impart a good to a bad, and were getting "zip" results.

"It is exactly this mechanistic approach we are trying to get away from", says Isachenko. "When our Ministry received Minlegpishchemash plants, we made a decision to distribute them among all administrations of our Ministry. First of all, we did not want to create a new, and weak at that, administration. Secondly, this way it will be simpler for the new plants to join our ranks."

Naturally, we had to start with retooling. The Ministry decided to increase financing of these projects this year by 150 percent, at the expense of current projects.

Early last year, TsNIITM formed teams of manufacturing and industrial engineers, who conducted detailed inspections of the new plants. Based on this analysis, typical problems have been summarized and identified, and priorities have been set.

Manufacturing of blanks turned out to be the weakest link of these plants. Due to their technological backwardness, the share of machining there was unjustifiably high. The share of precision casting was only 18 percent (compared to 85 percent in the defense industry), stamping - 16 percent (55 percent), and manual labor - 60 percent (15 percent).

Not just a gap - an abyss. It will take years to bridge it. But the defense industry is not in the habit of procrastinating, nor does it point fingers. Without waiting for the end of the overhaul, it has allocated a portion of its production capacity, in order to supply the new plants with high-quality blanks.

The second priority is expansion of tool and die making. In the former Minlegpishchemash there were 60 percent fewer tools and fixtures per worker than in Minobshchemash. This was another source of faults in the preparation of production. State-of-the-art welding technology is the third priority direction.

What interested me the most was exactly how they were going to transfer technology. Which route would they take? We can literally stuff any shop with Bosch and Fanuc machining centers, but this will make less sense than installing ordinary Voronezh or Lipetsk machine tools.

"We should be transferring principles of work organization", contends V. Isachenko. "Our industry has formed specific approaches to technology implementation, which accelerate this process multifold. We have a proven, clearly defined system of technological design of new machines, including early stages, before working documentation becomes available. We have proven to ourselves that any changes introduced at later stages lead to losses."

To train people to work faster and in a new fashion, the defense industry sent its assault force to Minlegpishchemash plants and assigned its KB [design bureaus] to support them.

At What Price?

Opponents of the "last trump card" usually say: "The defense industry has always achieved desired results because the state never cared about the cost. But we do not need machines made of diamonds at a vegetable-packing plant."

"Surely", agrees Isachenko, "once in a while I too voice similar concerns. One does not have to copy everything—it can be real expensive. But there is a whole gamut of machine-building technologies that significantly reduce production costs! They break up the set structure of blank usage."

But if it is an accepted practice here to save on metal, monetary investment in people is made without a stinge. Payroll problems were solved, and this has immediately allowed the management of the enterprises, if not to win over, then at least to keep qualified professionals.

And even the most tricky problem, housing, has not fallen by the wayside. It is definitely no secret that the defense Ministries, gathering under their wings the best professionals, were able to offer certain social benefits not available to ordinary mortals. What could be offer to a professional at Belopolsk Machine Building Plant, which cannot even put up a boiler room on its own? As we were informed by B. Pavlov, Head of Minobshchemash Main Construction Administration, the stake in building new housing will be made on khozsposob [a method of construction that involves the use of customer's labor and equipment], and the Ministry is ready to use its old connections with contractors. Two-three years from now, it is planned, the child care problem at Minlegpishchemash plants will be solved, and the housing problem will be solved by the year 2000.

Whenever we have talked recently to representatives of former Minlegpishchemash plants, everybody has been happy so far.

"According to our calculations", says Isachenko, "in two to three years we could bury the Gosagroprom with equipment manufactured today. But do they need such equipment? I don't think so. It is more important to improve the technological level of machinery, on the one hand, and of the plants themselves, on the other.

It looks like this conviction is well founded. The course to conversion has been embarked on in earnest.

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GOST 15.001-88—New Type of Standard

18610578 Moscow STANDARTY I KACHESTVO in Russian No 3, Mar 89 pp 34-37

[Article by O. V. Yaremenko and A. L. Terkel, candidates of technical sciences, VNIIS [All-Union Scientific Research Institute of Standardization] under the rubric "Perestroika of Standardization System: Problems, Research, Suggestions"]

[Text] The foundation-laying standard for the system of product development and organization for production (GOST [All-Union State Standard] 15.001-73) has existed for 15 years and undergone 11 changes. And not because it was poorly developed originally, but in association with the appearance of new provisions, new laws and decrees by the party and government. After all, this standard is a systematic organization standard and its regulations are based on the legislation in effect and standard-setting official documents.

The standard also specified the basic regulations for product development, such as the procedure for development, coordination and approval of technical documentation, for tests of products under development and in production, and for making decisions concerning the manufacture of products according to the results of an examination of test documentation and reports.

In spite of the fact that the product development procedure has been simplified considerably in recent years (especially after decree No 65 was issued by the USSR Council of Ministers on 14 January 1986), the standard's basis as an administrative order document remained as before and was not consistent with the new management terms. This caused numerous reprimands from industry.

In addition, the numerous changes made one of the most popular standards (it withstood nine editions with a total circulation of about a million copies) hard to read.

The appearance of the new standard to a certain extent marks the beginning of perestroika in standardization. It is based on the same democratic principles of the interplay of parties in product development as in the ISO and IEC international systematic organization standards. For the first time neither higher organizations nor gosnadzor [state committee for supervision] organs are interfering in the product development process, and compliance with all regulations of the standard is being assured by the customer, developer and manufacturer. Parties (management, institutes, local organs) can appeal to the USSR Gosstandart [State Committee for Standards] only in the case when disagreements arise.

The elimination of external interference by controlling organs does not signify that the standard's requirements are not compulsory. They are compulsory for work participants, because, on the one hand, they make it possible to organize the work optimally and to assure high-quality products, and on the other to assure the equality of the parties.

The words "informal agreement" have disappeared from the standard. The customer and developer bear complete responsibility for products and they do not shift it to others by means of informal agreements.

The standard extends to national economic products for production engineering purposes being developed not only by state but also by cooperative and public organizations and enterprises.

When the draft of the standard was discussed with branches of industry (and it was discussed extensively and openly) it was practically a unanimous opinion to exclude from the standard compulsory requirements the prohibiting of the development of products not conforming to the world standard. All previous experience showed that a high technical standard is formed not by prohibitions but by putting key economic factors into action, when achievement of the world standard will be profitable for the developer, manufacturer and consumer. This is confirmed by the experience of direct cooperation with foreign firms.

The fact that the development of products is being carried out totally according to an agreement between the parties made it possible to abandon the previously adopted particularization of possible product development options with the specific properties of the product taken into account. A single procedure was established for product development, both for state orders and direct orders from an enterprise. Exceptions are not made for manufacturing equipment for the internal needs of a ministry, for the simplest products, etc. The initial cause of so frequent terminological disputes concerning whether a product under development belongs to the specific type mentioned in the standard has disappeared now.

It is stressed in the new standard that the result of development is a scientific and technical product, and this means that the development contract must also be worded in accordance with the "Statute Concerning Contracts for the Development (Transfer) of Scientific and Technical Products" approved by the decree of GKNT [State Committee for Science and Technology] on 19 November 1987.

According to the new standard, it is not just the party that will consume the product which can be development's customer, but also the manufacturer and developer of the final products (in connection with the development of components) and an organization that has been charged with representing the interests of consumers. The necessity of appointing a head developer if several organizations take part in development has disappeared now: The problem is solved by itself based on the concluding of development contracts.

Like many international standards (e.g., the ISO series 9000 standards), the new standard not only sets requirements, but also suggests which up-to-date research and

design methods are to be used in order to produce high-quality products in a short time. The standard directs developers toward the formation of a scientific and technical stockpile, toward the development of their own experimentation base. In it experiments are treated not as an official means of testing a completed development, but as an integral component of development in the process of which the product under development is optimized. The fulfillment of this requirement makes it possible to implement the slogan "Experiment on the stand and not on the consumer!"

The participants themselves specify the engineering assignment development procedure. Therefore, its joint writing (the customer together with the developer) can be considered the best working option. This provision will make it possible to switch to the most efficient organization of the work: Instead of transferring papers, repeated informal agreements and mutual rebukes, the customer and developer solve all the necessary problems at a shared table. The form of the engineering assignment is not important. It is important only that this document contain sufficient specifications for the development and be recognized by the parties as the reference document for the work.

The new standard also touches on the question of the use of the standards in effect for products. The question arises in practice of what is to be done if a customer needs a product that differs from the specifications of the standards in effect. Can he order this product? This question was not even discussed previously. Any departure from a standard was considered a violation of it, and, therefore, quite correctly, standards were considered an obstacle to the development of highly efficient equipment, especially in cases when they contained excessive particularization. Only the introduction of changes in the standard gave the right to begin developing and producing the product. At the same time, changes were not always justified in particular cases.

Now it is possible to manage without changes if the customer is the initiator and the legitimacy of the specifications he gives for the product can be confirmed by local organs of USSR Gosstandart or its institutes. Now USSR Gosstandart is doing a great deal of work reviewing many standards in order to remove excess regulations. Only specifications defining the technical level, safety, environmental impact, compatibility and substitutability of products should remain in standards. Nevertheless, here cases are not ruled out when, in connection with individual particular features of the application of products, it is necessary to depart from certain specifications of the standard for the sake of improving the effectiveness of its application.

As already stated, questions relating to product development are resolved with the consent of the parties. But what about the case of initial development without a customer? In this situation the developer decides every question independently down to the presentation of the results of the development to the acceptance commission.

In the new standard, as in GOST 15.001-73, the making of prototypes and acceptance tests are called for as the principal option for rating the quality of developed products. However, with the customer's consent, not making prototypes is permitted when products are made in small lots, in the case of modernization, and also when the final products are produced by unitization from a unified set of components, such as finished parts, assemblies, units and modules. Abandoning the making of prototypes presupposes the sufficient perfection of the product in previous tests or in use.

A pilot model must be presented for acceptance tests in the absence of prototypes.

An experimental model can also be subjected to acceptance tests in place of prototypes. But in this case the technical documentation is developed as early as after the test results have been examined by the acceptance commission.

Acceptance tests are able not to be made in the case when the results of previous research or preliminary tests of samples of the product are sufficient for rating its quality and they are recognized by the acceptance commission.

The new standard directs developers and head organizations for types of products toward the standardization of the methods of acceptance and other tests, inasmuch as this is the most progressive method of assuring the completeness, reliability and comparability of test results. The need to develop its own routine and technique for each specific product is dispensed with when there is a standard or standard routine and technique for tests.

The question concerning future batch production or the use of piece products is decided collectively by the acceptance commission, which includes, besides the developer, the customer or principal consumer and the manufacturer. If there is a gospriyemka [state acceptance service] at the developing enterprise, then its representative is also included in the acceptance commission. The manufacturer, when it has a gospriyemka, can involve its representative as a consultant in the commission in order to facilitate its own further work with the commission. Experts from outside organizations, as well as organs that exercise supervision over safety, public health and evironmental protection, can be involved in the commission's work in accordance with the statute concerning these organs.

The developer organizes the acceptance commission's work, but the customer or principal consumer is appointed as its chairman.

If the manufacturer is the customer, then it is recommended that the principal consumer be invited to participate in the acceptance commission's proceedings in order to have an opponent defending its own interests.

Unlike the former procedure, the acceptance commission decides independently the future fate of the product: The

formal document approved by its chairman is the final document for deciding the question concerning production.

The developed or manufactured product's conformity with the specifications must be indicated in this document and recommendations must be given concerning its production or delivery to the consumer. For batch production, it is also indicated whether or not it is necessary to make a pilot batch. In so doing, it is compulsory to indicate the size of the pilot batch or the date it is to be made. The results of a rating of the product's technical level can be presented in the document if this is called for by the engineering assignment.

Comments and suggestions relating to further improvement of the product are written into the document when development shortcomings are revealed. Here the chairman of the acceptance commission can approve the official acceptance document only after measures for eliminating these shortcomings have been completed.

The mastery of production must end with tests of the pilot batch that confirm the production process's readiness for the batch production of products, and products must not be shipped to the consumer before these tests have been completed. However, for certain kinds of products this will result in the accumulation of a large number of finished products at enterprises, and this provokes the manufacturer to shorten the duration of tests to the detriment of their reliability.

This situation is also taken into account in the new standard. Shipping products before the completion of tests of the pilot batch is permitted by agreement between the manufacturer and consumer. An indication of this must be made in the delivery contract or in a separate agreement. But, in so doing, the manufacturer must confirm, as a minimum, the product's conformity with safety, public health and environmental protection requirements. In addition, if in the completion of tests of the pilot batch shortcomings of the product are discovered, the manufacturer is obliged to eliminate them in all the products manufactured previously, regardless of whether they are still at the enterprise or the consumer already has them. Products from the pilot batch are accepted in any case according to the results of acceptance testing (acceptance and delivery tests).

The question arises: under these conditions what is the role of head organizations for types of products, that previously took part in all development? Is this not a departure from a united technical policy for certain kinds of products? No, under no circumstances. A powerful means of carrying out a united technical policy remains in the arsenal of head organizations for kinds of products—through standards, including standards having long-range specifications, standards assuring product compatibility and substitutability, etc.

It is necessary to dwell in particular on the gospriyemka's participation in work on product development at the early stages.

Only developers (and the majority of them) consider the gospriyemka's intervention an encroachment on the creative process, and from the viewpoint of the legislation in effect they are right. On the other hand, others cooperate actively with gospriyemka personnel and consider this work helpful.[1]

It must not be forgotten that the gospriyemka does not represent the abstract interests of the state but protects the specific interests of the consumer, and under the new management terms must interact with the consumer in all questions pertaining to product quality. Now, unfortunately, the customer or consumer rarely utilizes the capabilities of the gospriyemka at the manufacturing enterprise.

Questions relating to tests of mass-produced products that go beyond the bounds of the development and organization of products for production and for which an approach based on an agreement between the parties cannot be used are not included in the standard. However, the exclusion of this section in no way signifies that such tests are not necessary.

It is planned in the very near future to approve a standard for the acceptance and testing of products to be produced. This standard will establish a unified procedure for the acceptance and testing of products both at enterprises where a gospriyemka has been introduced and at all other enterprises.

The change to the new procedure can involve certain difficulties associated with the abandonment of the usual administrative order methods. In addition, the standard does not now contain standard rules for decision making, the form and content of individual documents and other procedural questions. Based on experience gained in this respect and the results of research conducted, VNIIS is prepared to render procedural assistance in the introduction of GOST 15.001-88, taking into account the specific characteristics of the products to be developed.

Footnotes

1. Cf. STANDARTY I KACHESTVO, No 1, 1988.

Industrial Pollution of Chernozem Zone Discussed

18610410 Moscow PRAVDA in Russian 1 Mar 89 p 1

[Article under the rubric "Tracing a Rumor": "Chernozems Will Stay Clean"; first two paragraphs are PRAVDA introduction]

[Text] In the city of Voronezh any information on nuclear power is taken with keen interest. And understandably so: there is a working nuclear power plant 40km from the city, and another one is under construction just 5 km from it. Lately, Voronezh residents have been actively discussing the possibility of building a regional nuclear waste storage in the oblast. Not a word about this project has been published, but in the city it is being accepted as a known fact. What is going on? Is there

any ground for the talk? If so, how come the public does not have reliable information on the subject?

Our correspondent V.Stepnov has addressed these questions to Chairman of the Executive Committee of the Voronezh oblast Soviet of Peoples' Deputies A. Voropayev.

"First of all, Aleksey Makarovich, let us clarify the terminology. A lot of people associate nuclear waste with spent nuclear fuel, which is not quite the same thing".

"Indeed, spent nuclear fuel is kept at a power plant for a short period of time, and then it is transported to a proper nuclear enterprise for further processing. In our case, we mean radioactive waste that has formed during reactor operation. It can consist of products of water treatment, rags, oil, working clothes and leftover parts after equipment repair and preventive maintenance. The Novovoronezh AES [Nuclear Power Plant] only stores its own waste."

"Where, then, does the talk come from? Reliable and respectable people, who are being nominated for Peoples' Deputies, are promising their constituents that their programs would include the fight against creating such a site. Maybe its construction is being planned?"

"I am stating categorically and unequivocally: not at all. However, your question calls for a more detailed answer. I shall start with a short digression into history. Back in May of 1986, the USSR Ministry of Power and Electrification asked for a permit to perform engineering and geological work in the vicinity of the Novovoronezh AES, in order to find sites eligible for burial of nuclear reactor waste. We declined the request and asked them not to plan the nuclear waste burial site here. Then, however, the USSR Ministry of Nuclear Power applied last December to the oblast Executive Committee for a permit to build a prototype industrial regional enterprise for burial of radioactive waste. Having reviewed submitted information, we did not accept the Ministry's proposal. It was decided to decline the request."

"What was the reason for the refusal?""

"At present, there are 42 chemically dangerous facilities in the Voronezh oblast, such as the Rossoshan Chemical Plant and Synthetic Rubber Plant. A 320 km long section of the Togliatti-Odessa ammonia pipeline cuts across our oblast. The plan is to build a burial site for toxic waste of the oblast's industrial enterprises. How many more hazardous facilities can one put up in the Chernozem zone? From this region the country gets a substantial share of sugar, bread, meat and milk. We don't have the right to risk contamination of these agricultural products. And the most important thing is that Voronezh chernozem is priceless. Regardless of S&T progress, man will always feed off the land, and it ill behooves one to squander it. Our decendants will not forgive our wastefulness, no matter how important facilities seem. In the end, there is nothing more important than bread."

In conclusion, Aleksey Makarovich, do you think it is necessary that our population be broadly informed? It is immoral to conceal from the people facts that affect their health, their well-being and their very life."

"I agree. We must reform. Glasnost and democracy are not empty sounds, but real respect for public opinion."