DIFFERENTIAL SCANNING CALORIMETER
DATA ACQUISITION SYSTEM

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The kinetics of polymerization reactions are studied in our laboratory using differential scanning calorimeter (DSC) data at various temperature scanning rates and analyzed by a computer code based on a theory developed and expanded in this laboratory. This created the need for an efficient data acquisition system with a variable and accurate programmable data collection rate. This report discusses one such successful data acquisition system using a Bascom Turner recorder (BTR). It is a combination chart recorder, calculator, floppy disk storage device, and interface allowing data to be transferred to a printer, CRT, or computer. Step-by-step procedures are presented.
18. (Concluded)

polymerization reactions
crosslinking

curing
heats of reaction
This report was prepared by the University of Dayton Research Institute, Nonmetallic Materials Department, Polymer Group. This work was initiated under U.S. Air Force Contract No. F33615-81-C-5019, "Polymeric Materials for Advanced Aircraft and Aerospace Vehicles", with Dr. Donald R. Wiff as the principal investigator. It was administered under the direction of the Materials Laboratory, Air Force Wright Aeronautical Laboratories, Aeronautical Systems Division, Wright-Patterson Air Force Base, Ohio with Dr. T. E. Helminiak as the contract monitor. The author of the report was Ms. Marlene Houtz, University of Dayton Research Institute.

This interim report covers research conducted from August 1982 to June 1983.
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SECTION I
INTRODUCTION

The kinetics of polymerization reactions are studied in the Air Force Wright Aeronautical Laboratories (AFWAL) Polymer Laboratory, using data obtained through differential scanning calorimetry (DSC) and subsequently analyzed by application of a computer code based on a theory developed\(^1\) and expanded in this laboratory. This creates the need for an efficient data acquisition system with a variable and accurate programmable data collection rate. The data format must be in a form that can be transferred easily to a computer disk file for permanent storage and easily retrieved when needed for computer processing.

Until recently, data was obtained by a multicomponent system which consisted of a Hewlett Packard 3480D digital voltmeter (DVM), a Hewlett Packard 2570A coupler controller (CC), and a teletype unit with paper tape output capabilities. This system acquires an analog signal from the DSC (Perkin Elmer DSC-II), converts that signal to a digital form through the DVM, carries the signal through the coupler controller at a programmed data rate to a teletype unit which prints the data while simultaneously punching the information on paper tape. Additionally, an analog signal from the DSC sends the information to a strip chart recorder where the exothermic and endothermic transitions can be visually monitored. The multicomponent system diagram is shown in Figure 1.

![Multicomponent System Diagram](image)

Figure 1. Coupler Controller Data Acquisition.
The CC initiates the DSC to heat at a preset programmed rate from an initial temperature. The DVM picks up the changing mV signals while the CC sends these signals to the teletype at a continuous constant data rate. The range limits of the CC are 0.6 to 99.9 seconds/data point which is practical for this application.

The CC method is efficient and accurate. However, there are some drawbacks which resulted in its replacement by a Bascom Turner 4120 recorder (BTR).

1) The CC method has the disadvantage of being multi-component with multisource serviceability. Service on one component was available rapidly, while another component could take one month or longer. The circuit boards of the CC are no longer available for replacement, so repair, if ever necessary, could not be accomplished.

2) The data collected on paper tape has to be read through a paper tape reader located outside of the laboratory facility. The data was stored in one computer system and then transferred to another computer system for final permanent file storage. Additionally, paper tape data storage is cumbersome and outdated as floppy disks and magnetic tape cassettes are in current use with computer systems.

The following sections will discuss some of the features of the BTR, its operation, calculations, computer access, and data transfer. A comparison of the two systems will follow in Section VI.
SECTION II
BASCOM TURNER RECORDER FEATURES

The Bascom Turner recorder (BTR) is a combination chart recorder, calculator, floppy disk storage, and has interface options that allow data to be transferred to a printer, CRT, or computer. It is easy to set-up, operate, maintain, and occupies little space on a benchtop. The recorder has two input channels with a range of 10 mV to 10V. Both channels have a data collection rate of .001 to 999 seconds/data point. The analog data is digitized, displayed, and plotted simultaneously. The data collected can be Y-time or X-Y format. A total of 500 data points can be stored on a record and one disk will store 270 records of data. The data format is +XX.XXX for the range of 10 to 50 mV. Stored data can be recalled and compared with other data, expanded, condensed, integrated, and various mathematical manipulations.

Connecting the BTR to the DSC is relatively simple. The two ordinate (calorimetric) analog signals from the DSC are connected to the top of the BTR into channels 1 and 2 and the appropriate mV signal for each channel is set. It is advised to read the Bascom Turner Manual 2 section on initial operations for complete precautions.

Data acquisition via the BTR is fairly simple. The data collected from the DSC is an analog signal which is stored in a plot buffer, or temporary storage location, and plotted as Y versus time. The analog signal is acquired, converted to digital form, displayed on the recorder and stored in a plot or disk buffer. A schematic diagram of the process is shown in Figure 2. The details on buffer to disk transfer are discussed later in this report.
Figure 2. Bascom Turner Data Acquisition System.
SECTION III
OPERATION OF THE BASCOM TURNER RECORDER

A. Initial Operations

1. Load paper by lifting the carriage arm and placing the Z-fold stack on the right hand side.
2. Load program into disk drive until it clicks and close cover.
3. Insert felt tip pen into holder.
4. Power instrument up.

*Note: To protect amplifier, depress zero (green control switch) when a channel is not in use!

Upon power up, the program loads automatically into a memory buffer. Four dots will appear on the display indicating all functions are properly loading. If an error is detected while loading, an error message will appear on the display and the interpretation can be found in the instrument manual. When the recorder is fully loaded and ready, the recorder responds with "Hello" printed on the display.

At this time, data collection via the BTR can begin. Some preliminary commands will align the chart paper and label the incoming data.

B. Sample Data Collection

1. Plot 1 GO pen places a dot at X=X=0

If paper is not aligned properly use the following commands:

2. Plot 8 0 move pen .005" in the X direction
   Plot 8 1 move pen .005" in the Y direction
   Plot 8 2 move pen .005" in the -X direction
   Plot 8 3 move pen .005" in the -Y direction
   exit command with GO

To label the data for ease of identifying

3. Label 1 XXXXXX GO This is the date of the experiment
4. Status 11 n GO Set data rate channel 1
   Status 12 n GO Set data rate channel 2
where \( n = 120 \frac{Y}{X} \left( \frac{\text{final temp} - \text{initial temp}}{\text{heating rate}} \right) \)

\( n \) was derived from this equation:

\[
n = \frac{\text{msec}}{\text{data point}} = \frac{60 \text{ sec}}{\text{min}} \left( \frac{1000 \text{msec}}{\text{sec}} \right) \left( \frac{\text{min}}{X \degree \text{C} \text{(heat rate)}} \right) \left( \frac{Y \degree \text{C} \text{range scanned}}{500 \text{ data points collected}} \right)
\]

Normally for a scan from 323K (50°C) to 723K (450°C) \( n \) would be:

<table>
<thead>
<tr>
<th>Heating Rate (°/min)</th>
<th>( n )</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>600</td>
</tr>
<tr>
<td>40</td>
<td>1200</td>
</tr>
<tr>
<td>20</td>
<td>2400</td>
</tr>
<tr>
<td>10</td>
<td>4800</td>
</tr>
<tr>
<td>5</td>
<td>9600</td>
</tr>
</tbody>
</table>

5. Set channel 1 on 10 mV; channel 2 on 20 mV. This is to ensure against data loss due to off scale or over shoot.

6. ACQUIRE 1 GO (Pen Up) (Do not push heat on the DSC at this time) This is to find where the pen is with respect to desired location. Reposition pen by moving zero control on DSC depending on transition expected.

7. ACQUIRE 9 GO Stop this acquisition

NOW ACTUAL DATA COLLECTION BEGINS:

8. There are 3 options:
   1. ACQ 1 GO* (pen down) ch 1 collection
   2. ACQ 2 GO* (pen down) ch 2 collection
   3. ACQ 3 GO* (pen up) both channels

9. Note: push HEAT on DSC and GO* on BTR simultaneously.

At this point, data acquisition is in process. If option 1 is used, the data from the DSC will go into Plot Buffer A (PBA) and then plot simultaneously. If the data collection rate is very fast, the plotter will lag behind actual collection; however, it is plotting from the buffer memory so no data is lost. If option 2 is used, the data will go into Plot Buffer A (PBA) and plot. If option 3 is used ch 1 data will be stored in (PBA)
and ch 2 data in (PBB) and the plotter will attempt to plot X-Y which in this case is nonsense as the data desired is Y-t. It is for this reason the pen is left up. The desired plot(s) can be obtained in the following manner:

10. Plot GO
    Disk 2 GO
    Plot ch 1
    Send this data to disk for permanent storage if desired. A disk address will appear on the display which should be recorded in a notebook.

11. Cal 22
    Exchange ch 1 (PBA) and ch 2 (PBB) data. This is necessary as only PBA will send to disk or plotter.
    Plot GO
    Plot ch 2 which is stored in PBA now after the exchange
    DISK 2 GO
    Send ch 2 data to disk for permanent storage if desired and record disk address.
SECTION IV
BASCOM TURNER CALCULATIONS FOR KINETICS

One of the calculations necessary to obtain kinetics of polymerization reactions is the subtraction of one data set from another or what is referred to as "baseline subtraction". This subtraction corrects for errors in the baseline slope due to instrument factors and/or sample factors. This subtraction can be accomplished by the kinetics program, however the resultant curve can be seen immediately on the BTR without going through computer processing. Another advantage is the baseline subtracted curve can be scaled up if necessary or compared with another curve previously stored on the disk.

Baseline correction can be done from data stored on disk or with data already in the plot buffer memories. Assuming the original curve 1 is at disk address 111 and the baseline curve 2 at disk address 222, the resultant subtraction is curve 3 as shown in Figure 3. The Bascom Turner commands to accomplish this are:

1. DISK 1 222 GO Baseline is copied from disk to PBA if not already there.
2. CAL 21 Copy baseline to PBB (actually exchange PBA with PBB)
3. DISK 1 111 GO Original curve 1 now in PBA (retrieved from disk address 111)
4. CAL 24 * Subtract curve 2 from curve 1 or PBA-PBB
5. PLOT GO Plot new curve 3 which is in PBA
6. DISK 2 GO Store new curve, record address

*Note: this subtraction of curve 1 - curve 2 or PBA-PBB results in the new curve held in memory at PBA. If curve 1 is new data not stored on disk it will be lost as this command overwrites the contents of PBA.

It may be necessary after baseline subtraction to shift the curve's position. In some cases the new curve will appear off scale; however, no data is actually lost as these new values are in the plot buffer memory but exceed the limits of the plotter as set.
To shift the curve use the following commands:

7. CAL 18 XX.XX GO Add XX.XX to all values of the curve. Shifts Y axis up.
CAL 18 - XX.XX GO Subtract XX.XX. Shifts Y axis down.

Curve 4 of Figure 3 is curve 3 plus 3.00 shift upward.

There may be cases where a sample yields a small peak curve and scale-up of this curve will aid the kinetics program in locating the peak and calculating the area under the curve.

8. CAL 17 XX.XX GO Multiply curve by XX.XX.

Curve 1 of Figure 4 was multiplied by 3.00 which resulted in curve 2. The curve appears to have gone off scale; however, shifting the curve downward by 3.00 (CAL 18 - 3.00 GO) resulted in curve 3. Notice that scaling up the curve also scales up any noise, baseline slope, and other instrumental factors. Also note that when a curve is multiplied or divided (CAL 17 - XX.XX GO) the appropriate scale factor will need to be corrected for the weight of the sample before running through the kinetics program. In other words, if the sample weight is Y.YY and the resultant curve was multiplied by X.XX, the sample weight will need to be corrected by this factor X.XX(Y.YY). A shift upward or downward of the curve will not affect kinetic calculations provided the curve does not go off scale.

Another feature of the BTR is the ability to integrate a curve. The integral can then be used to find the heat of reaction of a sample. Before actual integration begins, be sure the data has been stored permanently on disk. The commands for integration are:

DISK 1 AAA GO Retrieve address AAA
PLOT GO Plot curve

The section of the curve to be integrated must be lowered to zero on the Y-axis. It is not important if other sections of the curve go off scale as only the area to be integrated must be on scale and the beginning and end of the curve must be on zero.
Figure 4. Example of Curve Scale-up.
Curve 1 of Figure 5 is the original curve stored at address AAA. Curve 2 was accomplished by subtracting 1.93 from curve 1 thus lowering the beginning and end of the curve to zero. The command used was:

- \text{CAL 18} - 1.93 \text{ GO} \quad \text{shift axis by 1.93 downward}
- \text{PLOT GO} \quad \text{plot new curve}
- \text{CAL 13} 3.5 - 8.00 \text{ GO} \quad \text{Integrate between X-axis valves 3.5 and 8.0}
- \text{PLOT GO} \quad \text{Plot the integral; note the original curve and the new curve will be lost if not stored on disk as the integral is over written in PBA.}

The height of the integral $\int y dt$ is then used to find $\Delta H$.

$$\Delta H \text{ cal/gram} = \frac{1}{200} \left( \int y dt \right) \left( \frac{\text{mcal}}{\text{sec}} \right) \left( \frac{\text{data rate}}{-\text{mg}} \right)$$

For the example in Figure 5, mcal/sec = 20, data rate = 600, weight = 4.15 mg.

$$\therefore \Delta H = \frac{1}{200} (8.5)(20)(600)/4.15 = 121.44 \text{ cal/gram}$$

In some cases, the curve to be integrated will have the end point higher or lower than the beginning. This will cause a problem when integrating as the true area will not be found unless corrections are made. In Figure 6 the beginning of the curve is at 1.3 on the y axis and the end at 0.62. To correct this a generated curve, BASELINE was manipulated to the desired slope by CAL 18 and CAL 17 commands and subtracted from curve 1. The resultant curve 2 has the beginning and end at 1.7 and can be moved to zero (CAL 18 - 1.70 GO) and subsequently integrated as usual.

A quick summary of the commands for the Bascom Turner needed for DSC data acquisition are given in Table 1 and the complete detailed description of all keyboard commands can be found in section 5 of the instrument manual. The aforementioned commands are the basic commands for obtaining data for kinetics.
Figure 5. Example of Integration Under a Curve.
Figure 6. Corrections for Integrating Curve.
# TABLE 1
BASCOM TURNER RECORDER FUNCTIONS
NEEDED FOR DSC DATA ACQUISITION

1) PLOT FUNCTIONS

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLOT 1 GO</td>
<td>pen places a dot at 0,0 of the paper</td>
</tr>
<tr>
<td>PLOT 8 0 GO</td>
<td>moves pen .005&quot; in the X direction</td>
</tr>
<tr>
<td>PLOT 8 1 GO</td>
<td>moves pen .005&quot; in the Y direction</td>
</tr>
<tr>
<td>PLOT 8 2 GO</td>
<td>moves pen .005&quot; in the -X direction</td>
</tr>
<tr>
<td>PLOT 8 3 GO</td>
<td>moves pen .005&quot; in the -Y direction</td>
</tr>
<tr>
<td>PLOT 5 n GO</td>
<td>move paper forward n pages or backward -n pages.</td>
</tr>
</tbody>
</table>

2) ACQUIRE FUNCTIONS

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACQ 1 GO</td>
<td>collect data channel 1 store in PBA and plot in Y-t</td>
</tr>
<tr>
<td>ACQ 2 GO</td>
<td>collect data channel 2 store in PBA and plot in Y-t</td>
</tr>
<tr>
<td>ACQ 3 GO</td>
<td>collect data from both channels store ch 1 in PBA and ch 2 in PBB</td>
</tr>
<tr>
<td>ACQ 9 GO</td>
<td>stop acquisition and plotting</td>
</tr>
</tbody>
</table>

3) DISK FUNCTIONS

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DISK 1 AAA GO</td>
<td>copy from DISK address AAA and store in PBA</td>
</tr>
<tr>
<td>DISK 2 GO</td>
<td>store PBA on disk at address displayed</td>
</tr>
<tr>
<td>DISK 3 AAA GO</td>
<td>ERASE ADDRESS AAA; data in PBA will be lost.</td>
</tr>
<tr>
<td>DISK 5</td>
<td>Display available disk space</td>
</tr>
</tbody>
</table>

4) CALCULATIONS

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAL 13 X.XX - X.XX GO</td>
<td>INTEGRATE ( \int y , dt )</td>
</tr>
<tr>
<td>CAL 15</td>
<td>smooth curve</td>
</tr>
<tr>
<td>CAL 17 XX.XX GO</td>
<td>multiply (scale up) by XX.XX</td>
</tr>
<tr>
<td>CAL 17 -XX.XX GO</td>
<td>divide by XX.XX</td>
</tr>
<tr>
<td>Bascom Turner Recorder Functions Needed for DSC Data Acquisition</td>
<td></td>
</tr>
<tr>
<td>---------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td><strong>CAL 18 XX.XX GO</strong></td>
<td>add XX.XX to curve, shifts Y axis</td>
</tr>
<tr>
<td><strong>CAL 18 -XX.XX GO</strong></td>
<td>subtract XX.XX from curve, shift Y axis</td>
</tr>
<tr>
<td><strong>CAL 21</strong></td>
<td>copy PBA to PBB or ch 1 to ch 2</td>
</tr>
<tr>
<td><strong>CAL 22</strong></td>
<td>exchange PBA and PBB</td>
</tr>
<tr>
<td><strong>CAL 23</strong></td>
<td>add PBA to PBB; result stored in PBA</td>
</tr>
<tr>
<td><strong>CAL 24</strong></td>
<td>subtract PBB from PBA, result stored in PBA</td>
</tr>
<tr>
<td><strong>CAL 25</strong></td>
<td>multiply PBA by PBB, result stored in PBB</td>
</tr>
<tr>
<td><strong>CAL 26</strong></td>
<td>divide PBA by PBB, result stored in PBB</td>
</tr>
<tr>
<td><strong>CAL 27</strong></td>
<td>average (PBA + PBB/2), result stored in PBB</td>
</tr>
<tr>
<td><strong>CAL 41 GO</strong></td>
<td>send data in PBA to the execuport</td>
</tr>
<tr>
<td><strong>CAL 474 GO</strong></td>
<td>set baud rate at 300 for transfer to execuport</td>
</tr>
</tbody>
</table>
SECTION V
SENDING THE ACQUIRED B.T. DATA TO A CDC COMPUTER

The kinetics computer program is currently written in fortran IV and run on a CYBER 750 computer. The bascom turner is connected by cable to an execuport 300 terminal with an acoustic coupler for telephone interface. Some modification was required in the kinetics programs to accept BT format.

Sending the acquired data to a permanent file is relatively simple. First, make sure the cable from the BTR is connected to the execuport at the plug-in marked external device. The cable must be in securely at both sites. Inside the execuport the control parameters are to be set on the following: Mode = line, Duplex = half, char/sec = 30, parity = even, QSL = lower. Now the computer number can be dialed up and at the sound of a high pitch tone the phone can be placed in the acoustic coupler of the execuport. The execuport will light up READY in green.

The following commands are performed through INTERCOM, a system which provides time sharing access to the CYBER computer. The initial steps necessary for access are as follows: The underlined commands are to be keyed into the terminal, those without are the systems response. After each command has been keyed in push RETURN to send the command to the computer. If a mistake has been made push the BACK SPACE key and retype command.

1. At the Terminal

   LOGIN, XXXXXXX, ZZZZ
   COMMAND - EDITOR

   .F, C=80
   .C
   100=

   XXXXXXX = problem#
   ZZZZ = code word
   system responds with
   COMMAND mode
   Sets up editor mode,
   systems response..

   Sets format to receive 80
   characters
   Create a file
   Terminal sends out the first
   number and waits on the BT
to send
2. On the BT (assuming disk is in and memory loaded)

CAL 474 GO  
sets baud rate at 300
DISK 1 AAA GO  
send data set AAA to PBA
CAL 41 GO  
send contents of PBA to the CDC

3. At the Terminal

The terminal will start receiving data. The data will appear similar to the following: (A condensed data table appears in Fig. 7.)

<table>
<thead>
<tr>
<th>ADR</th>
<th>REC</th>
<th>DATE</th>
<th>CHN</th>
<th>TIME</th>
<th>SC</th>
<th>MIN</th>
<th>#PTS</th>
<th>CUR</th>
<th>NX</th>
</tr>
</thead>
<tbody>
<tr>
<td>107</td>
<td>000</td>
<td>112581</td>
<td>1</td>
<td>000600</td>
<td>00</td>
<td>000</td>
<td>500</td>
<td>107</td>
<td></td>
</tr>
<tr>
<td>02.825</td>
<td>02.975</td>
<td>03.035</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>03.647</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

After completion of this data set, two dots will appear and the next data set can be sent.

4. On the BT

DISK 1 AAA GO  
send another data set to PBA
CAL 41 GO  
send this set to CDC

5. At the Terminal

The terminal will start receiving data

A maximum of 3 data sets should be sent at one time as the computer may log out automatically not realizing it is in use.

After the 3rd data set:

6. At the Terminal

..=

Exit from create mode.
At this point, terminal starts spewing out data with line numbers as the terminal could not keep up with the BT although all data was received. As this data spewing is time consuming, boring, of no value, and wastes paper, it is best to exit from this mode by the following: push escape, then & A. This may need to be repeated until the editor mode (..) is shown.

..REQUEST, A, *PF
request, any file name A-Z for permanent file space.

..S,A,N,O,A
give, file A, nonsequential, overwrite, all
..CATALOG, A, TEMP, CY=1 Catalog file A under the name TEMP at cycle 1
..C Create the next series of data

7. On the BT
Repeat steps 4 and 5 until remainder or up to 3 data sets have been sent. Then repeat steps 6 requesting a permanent file with a new name, B, and catalog under CY=2. Repeat for as many times as necessary to send all data needed.

8. On the Terminal
Assuming all data is sent and stored, it now needs to be merged and the file cleaned up and sample values added.

..E,A,S Edit file A sequentially
..S,Z,M,N,ALL Save in Z, merge, nonsequential, all

..E,B,S, Edit file B
..S,Z,M,N Save in Z merging nonsequential
repeat until all files are merged in file Z

..E,Z,S Edit the new file sequentially
..L,A,/ADR/ List all lines with ADR in them, this will locate the beginning of each data set

100=ADR
   =ADR
   =ADR
   =ADR System's response with numbers to the left of the equal sign representing line numbers where ADR is found

Now list above and below each ADR to locate what is there.
For example:

..L, 580,620
580=02.852 03.872 etc.
590=..
600=ADR REC DATE etc.
610=107 000 112581 etc.
620=03.261 04.872 etc.

580 will be the end of the previous data set
600 will be the beginning of data set 107
(disk address)
at this point delete lines 590 through 610 as they are not needed for the kinetics program
Delete 590 to 610
Add to line 590 in increments of 2
Here is where values for each sample will be inserted

Hit return and this will leave a blank line. This blank line indicates the end of a data set in the kinetics program

Title of scan and identifying what sample is

Weight of sample in mg
Mcal/sec range on DSC, see note below
Heating rate °/min.
Starting temperature of DSC in Kelvin
Data rate in sec/data pt.

Note: On BT the data rate has to be msec/data pt. so if the data rate was 600 it will be recorded as 0.6 here.

Repeat listing lines before and after ADR to clean up the file. Insert the appropriate sample weights, heating rates, etc. where necessary. If there appears to be data that repeats zeros at the end of a file, delete those lines with zero. The BTR inserts zeros in a record where no data has been collected.

*For mcals/sec range on 20mV setting multiply the range of the DSC by 2. For 10mV setting the range is that of the DSC setting.

At the end of the file, two blank lines should be inserted. This signals to the program the data set is final and analysis can continue.

List last line of file to find end
System response-line #XXX
List a few lines before to check for zeros in file. If found, delete those lines.
Leaves two blank lines, XXX
Must be any number higher than XXX which was the last line of the file.
Now the file is completely edited and can be saved in a permanent file.

..REQUEST,Q,*PF Request to save the edited version in file Q.
..S,Q,N,O,A Save this file.
..CATALOG,Q,INPUTDATA, Catalog this file, RP=retention period in days
RP=987

The data sets are now ready to use as input data to the kinetics program.
SECTION VI
COMPARISON OF BT RESULTS WITH THE
COUPLER CONTROLLER METHOD

The CC method receives an analog signal from the DSC and converts that signal to a digital form through the DVM. The signal is then picked up by the CC at a programmed data rate and printed on paper and simultaneously punched onto paper tape. A second analog signal is sent to a strip chart recorder.

The BTR receives an analog signal from the DSC which is also converted to digital form. The signal received is stored in a plot buffer memory, PBA or PBB, and is acquired at a programmed data rate. The data stored in memory is then permanently stored on floppy disk. A plot can also be obtained from the plot buffer memory.

The major difference between the two systems is in the CC system. The data is acquired through several components and in the BTR through one component. With the CC system the data must be read through a paper tape reader. The BTR can send the data to the computer through a terminal. The BTR can also manipulate the data mathematically by scale-up, baseline subtraction, or normalize.

The other advantages of the BTR have been stated elsewhere, however, the main advantages is floppy disk storage. This allows 270 data curves to be stored on an eight by eight inch flat magnetic floppy versus punched paper tape which would require considerable more space. Also the ease of data transfer to a computer permanent file is desirable.

A data comparison of the two systems indicate very little difference. The CC method acquires data with values $+XX.XX$ while the BTR acquires values $+XX.XXX$ when set on a 10, 20 or 50 mV scale. With both systems a set of calibration data is used to correct for thermal lag, area heat constant, and temperature using data obtained from pure elemental samples such as lead or indium. The Y axis is a mV reading relating to mcal of heat
and the X axis (temperature) are both corrected by the calibration.

A plot of rate of evolved heat in mcals/mg-sec versus temperature in degrees Kelvin is shown in Figure 8 for the two systems. The data sets were not taken simultaneously and thus, the weights of the samples varied. The error in sample weight would make a difference in the mcals/mg-sec Y axis scaling as can be seen. The differences in the X axis (temperature) are due to lag factors from the CC which are now corrected for.

The BTR can be updated to other terminals as the need arises. An execuport terminal was chosen as it was currently available. Also, it can be used with any instrument yielding analog signal output in the range of 10 mV to 10V and up to two channels of input. Additional software options are available as are update program versions. The information given in this report is Version 4.
Figure 8. Bascom Turner and Coupler Controller Data.
REFERENCES
