UNCLASSIFIED

MLM-MH-48-61-0020

This document consists of 6 pages

and 1 figure.
This is copy 10 of 14A

MONSANTO CHEMICAL COMPANY - UNIT III

MLM-23

PROGRESS REPORT

January 16-31, 1948

CALORIMETRY RESEARCH GROUP

J. F. Eichelberger, Miss A. Geiger, K. C. Jordan,
Miss G. P. Oldaker, J. R. Parks, and J. H. Wright

SPECIAL REREVIEW FINAL DETERMINATION	
Classification:	<u>Unclassified</u>
Category:	
Signature:	<u>P. B. Dowd</u>
Date:	<u>2/17/80</u>

ABSTRACT

Calorimetry

1. Twenty-six samples have been assayed for other groups.
2. Unit IV calorimeters agree with Unit III calorimeters to 0.5 per cent.
3. The calorimeters of type 30 are practically finished. Experiments on the significance of speed and sensitivity continue and are discussed at length.
4. A 2.68 Curie sample for tests of heat distribution error has been procured.

Mathematical Analysis

1. The half-life determination from the third set of Unit III counting room data was completed.
2. The formula developed by the Calorimetry Group for the speed of calorimeters was evaluated.
3. Text books and articles treating the theory of probability and its application, especially counting techniques, have been studied.

DETAILED REPORT

Summary of Assays

<u>Calorimeter No.</u>	<u>No. of Samples</u>
30-II	14
29	7
2	4
30-IV	1
	<u>26</u>

UNCLASSIFIED

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

~~SECRET~~
MASTER

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

Calorimetry Progress Report

Six of these twenty-six samples were assayed a second time in a different calorimeter.

Comparison of Unit IV with Unit III Calorimeters

Four samples which had previously been assayed at Unit IV were measured in calorimeters 29, 30-II, and 30-IV. Each sample was assayed twice at Unit III. The average difference between the Unit IV and Unit III measurements is 0.5 per cent. A memorandum containing the results has been prepared.

Theoretical Study of Speed and Sensitivity

The theoretical study of speed and sensitivity has been slowed by the large number of terms entering the equations. This has necessitated a study of methods of making approximations that will lead to simpler equations without an inordinate loss of accuracy.

The results are still incomplete and cannot be presented now. However, several comparisons of theory with experiment gave encouraging results.

Calorimeter 30

The construction of the five calorimeters of type 30 has been almost completed. One of the calorimeters has been modified slightly for experimental purposes and the change of this calorimeter to its final form remains to be done.

Experimental work on calorimeter 30 has been continued on the subjects of speed and sensitivity. Most of the research concerned the effect of heat capacity on speed. There follows a detailed discussion of the results.

Balancing of a Calorimeter

As has been stated previously, the time to run a sample by the differential method may be reduced if the speed and sensitivity of both sides are matched. The more closely they are matched the faster the equilibrium bridge potential may be reached. Of course one is limited when running a sample and heater by the fact that both sample and heater cannot be started at the same temperature. This may be partially corrected by cooling off the sample before putting it in the calorimeter and then setting in the heater current when the bridge potential returns to its zero value, and so the sample and heater will then warm up the thermal units at the same rate. When making a calibration run (equal heater power in both arms), the heaters are both at bath temperature at the time current is introduced into both heaters. Therefore, if the sensitivities and speeds are identical for both sides, the bridge potential will not change and the calibration will be made in a few minutes.

UNCLASSIFIED

CALORIMETER 30

480001

UNCLASSIFIED

~~SECRET~~

~~SECRET~~

-3-

UNCLASSIFIED

Calorimetry Progress Report

It seems quite possible that calibration runs could be made in fifteen minutes with the proper balancing of the calorimeter. This means that a complete check on all characteristics of both sides of the calorimeter could be made in fifteen minutes. Any small change anywhere in the calorimeter, (including heater resistances, bridge coils, moisture, and air gaps) would change this calibration run quite noticeably. Of course if exactly the same change occurred on both sides, no effect would be noticed. This condition, however, appears very unlikely to happen.

Now to investigate the possibilities of balancing the sensitivities and speeds of both sides.

So far as the sensitivity is concerned this cannot be changed easily since it depends entirely upon the resistance of the bridge coils and upon the dimensions of the air gap between the thermel and isothermel. The thermel cannot be removed easily. If it could, perhaps scotch tape could be wrapped around the slower thermel to reduce the air gap. This would require the thermel to be removed several times to check the change of sensitivity induced by each change in air gap which seems to make the balancing of sensitivities impractical in calorimeter 30 at least.

The balancing of speeds, however, may be approached in a very practical manner. It is well known that any change in heat capacity of the calorimeter changes the speed. This holds true so long as the change of heat capacity is within the air gap between thermel and isothermel. For our purposes the best place for changing the heat capacity is within the sample and heater containers. Any mass of material with a high specific heat may be placed within the sample container of the faster side of the calorimeter to slow it down to the speed of the other side. The question arises as to how large a mass is required to slow the calorimeter by a given amount. Experiments were run to find such a relationship.

The calorimeter picked for this experiment had no noticeable difference of speed between the two sides, as indicated by the differential curve which decreased exponentially to a $-70 \mu\text{v.}$ equilibrium, showing only a difference in sensitivities.

Then 98.8 grams of aluminum was placed in the sample container and a differential curve plotted again. The bridge potential now dropped to -6794 micro-volts in twelve minutes and thirty-five seconds and then came slowly back to $-70 \mu\text{v.}$ as before, showing a large change in speed but no change in sensitivity, as expected. Knowing the time the bridge potential reaches a maximum (or minimum) and the maximum (or minimum) bridge potential, it should be possible to compute the new speed (λ). The equation of the differential bridge potential versus time is as follows:

$$e^{-\lambda st} = \frac{s_s - s_h}{s_s} + \frac{s_h}{s_s} e^{-\lambda ht} - \frac{BP}{CS_s}$$

UNCLASSIFIED

~~SECRET~~

Calorimetry Progress Report

where e = base of natural logs.

λ_s = speed of sample side.

S_s = sensitivity of sample side ($\frac{\mu V.}{mC.}$).

S_H = sensitivity of heater side.

λ_H = speed of heater side.

BP = bridge potential (in μv).

t = time in minutes.

In this equation the sensitivities of the heater and sample sides are known (S_s & S_H), also the speed of the heater side λ_H is known. Therefore, knowing the bridge potential at any given time, it should be possible to calculate the speed of the sample side (λ_s). Probably the best point to use is the maximum bridge potential and time at which it occurs since it is a very unique point. The sensitive galvanometer will show this point to the second. It should be emphasized that if the operator misses this point it should not worry him as another point a little later will be just as good.

In two particular cases the speed as calculated from this equation checked the directly measured speeds to within ten per cent. There are three reasons why the change in speed is best determined by the differential method. (1) Small changes are much more noticeable, (2) the change is compared directly with the other side, and (3) the speed may be determined in 15 minutes whereas directly it would take more than an hour.

So far four different masses of aluminum have been placed in the sample container: 98.8, 49.6, 24.8, and 8.3 grams respectively. The difference between the maximum bridge potentials reached and the final equilibrium bridge potentials turn out to be almost directly proportional to the mass of aluminum used, i.e., 98.8 grams of aluminum produced 62.8 micro-volts per gram, 49.6 grams produced $60.0 \frac{\mu V.}{gm.}$, 24.8 - 59.0 $\frac{\mu V.}{gm.}$ and 8.3 grams produced $60.0 \frac{\mu V.}{gm.}$. From this data it is apparent that if, when calibrating a calorimeter differentially, one got a maximum or minimum point of 600 micro-volts, then by placing an aluminum slug of 10 grams in the faster side, the minimum or maximum point would disappear causing equilibrium to be reached sooner.

Besides aluminum, brass and bakelite have been used to slow up the sample side. It is interesting to note that 46.4 grams of bakelite slows down the calorimeter as much as 73 grams of aluminum, or bakelite is 1.57 times more effective. Also the specific heat of bakelite is 1.5 times as great as aluminum. This shows that the conductivity of the mass involved is unimportant and that the slowing down property for equal masses is proportional to the specific heat. Brass was only one half

Calorimetry Progress Report

as effective as an equal mass of aluminum and also it has only one half the specific heat of aluminum. It is possible then that this method could be used in comparing specific heats of materials.

Another reason to believe that the conductivity of any material placed inside the heater causes no appreciable effect is that regardless of whether the aluminum block was in metallic contact with the heater container or insulated from it, the speed did not change.

Below in tabulated form are results from experiments run so far.

<u>Material</u>	<u>Mass</u>	<u>BP</u> <u>max.</u>	<u>λ</u> <u>s</u>
Aluminum	98.8 g.	6180 μ v.	.07273
Aluminum	49.5 g.	3274 μ v.	.11413
Aluminum	24.8 g.	1127 μ v.	.12453
Aluminum	8.3 g.	525 μ v.	Not Calculated
Brass	133 g.	3875 μ v.	Not Calculated
Bakelite	46.4 g.	4551 μ v.	Not Calculated
Air	0	0	.1745

Heat Distribution Error

The Micro Assay Group at Unit IV has prepared for us a 2.68 Curie sample packed in a small platinum can 8.5 mm. high and 3.5 mm. in diameter. This sample is to be used in the study of heat distribution errors.

Mathematical Analysis

1. The least squares analysis of the third set of data obtained from the counting room was completed, and the half-life obtained was combined with the half-lives obtained from the first two sets in the calculation of a weighted average.
2. The calculation of the coefficients for the terms of the infinite series in the equation for the speed of a calorimeter was continued. The calculation had been interrupted because Bessel functions not available in tables were required in order to compute the coefficients. However, the use of an asymptotic expansion made it possible to compute approximate values of the Bessel functions which the formula required. Several approximations to the speed of the calorimeter were computed using an increasing number of terms of the series and varying the time.
3. In order to assist in the preparation of several lectures on the theory of probability and its application to counting, library work has been done on these topics.

UNCLASSIFIED

~~SECRET~~

-6-

Calorimetry Progress Report

FUTURE PLANS

Short range plans involve only the completion of work now in progress.

J. F. Eichelberger

JFE/rcc

DISTRIBUTION:

1. - Unit III
2. - Unit IV
3. - Site Y
4. - Site Y
5. - Area Manager
6. - Area Manager
7. - Area Manager
8. - Author
9. - H. P. Knauss
10. - N. M. Wolfe ✓
11. - Central Files
12. - Central Files
13. - Central Files
14. - Central Files

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

This document contains restricted data within the meaning of the Atomic Energy Act of 1946 and/or information affecting the national defense of the United States within the meaning of the espionage act 50 U.S.C. 31 and 32, as amended. Its transmission or the revelation of its contents in any manner to an unauthorized person is prohibited and may result in severe criminal penalty.

~~SECRET~~

UNCLASSIFIED