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Proceeding

The 2nd International Conference of the Indonesian Chemical Society 2013

ICICS 2013

Research in Chemistry for Better Quality of Environmental

Universitas Islam Indonesia, Yogyakarta, Indonesia
October, 22 - 23th 2013

Abdul Kahar Muzakkir, Conference Hall
Universitas Islam Indonesia (UII), Yogyakarta.
Kampus Terpadu, Jl. Kaliurang KM 14,5 Sleman, Yogyakarta.

Preface

The international conference is an annual conference of the Indonesian Chemical Society (Himpunan Kimia Indonesia, HKI). In the year 2013, the mandate of the organizing committee was given to the HKI Yogyakarta branch and also supported by Department of Chemistry of Universitas Negeri Yogyakarta (UNY), Department of Chemistry of Universitas Gadjah Mada (UGM), Department of Chemistry of Universitas Islam Negeri Sunan Kalijaga (UIN Suka), National Nuclear Energy Agency (BATAN Yogyakarta), and Volcano Investigation and Technological Development Center (BPPTK Yogyakarta). For the year 2013, ICICS 2013 is hosted by Department of Chemistry, Faculty of Mathematics and Natural Sciences, Islamic University of Indonesia, Yogyakarta from October 22 – 23, 2013. This conference was also prepared to celebrate 70th anniversary of Universitas Islam Indonesia.

The Sicentific Programme of ICICS2013 comprises the following:

1. Invited Speaker 11 papers
2. A total 256 paper for parallels sessions
    a. Organic Chemistry 32 papers
    b. Inorganic Chemistry 43 papers
    c. Physical Chemistry 37 papers
    d. Analytical Chemistry 68 papers
    e. Education Chemistry 23 papers
    f. Biochemistry 43 papers

The breakdown of the presentation is as follows:

Session	Oral	Poster	Total
Invited Speaker	11	0	11
Organic Chemistry	25	7	32
Inorganic Chemistry	38	5	43
Physical Chemistry	31	6	37
Analytical Chemistry	61	7	68
Education Chemistry	22	1	23
Biochemistry	34	8	43
Total	**222**	**34**	**256**

Yogyakarta, 25th November 2013

ICICS 2013

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Calorimeter Design Being Monitored by Digital Microscope

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Abstract

The purpose of this research is to make simple calorimeter design using a digital microscope that can be used for monitoring of temperature ina simple calorimeter and to determine the accuracy and precision of that. This simple calorimeter is made of severalcomponents such as styrofoam cup, thermometer, digital microscopes, and computers as the main controller.The simple calorimeter has been tested on determination of the neutralization enthalpy of the strong acid(HCl) with a strong base (NaOH), ammonium chloride salt (NH_4Cl) with a strong base (NaOH) and a strong acid (HCl) and a weak base (NH_4OH). The enthalpy of the sample resultswere compared with the result value of the enthalpy in the literature.The results showed that the measurement of the enthalpy of neutralization reaction of NaOH with HCl andHCl with NH_4OHhas good accuracy namely 98.0%. - 99.4%. While measurements of reaction enthalpy NH_4Cl with NaOH has little accuracy namely 6.9% - 11.5%.

Keywords: Calorimeter, Enthalpy Neutralization, Digital Microscope, Thermometer.

1. Introduction

Asolidhastwotypes ofthermalenergystoredin form of thevibrational energy where atoms vibrate aroundthe position ofequilibriumandkinetic energy of free electrons. Whenasolidabsorbsheattheinternalenergystoredin thesolidincreasesas it is indicatedby therise in temperature. The change of energy due totemperaturecandetermine theproperties ofthe thermalproperties ofsolids. One of the thermal propertiesis thecapacityof heat (Sudirham andNing, 2010).

The heat capacityof themediaorsamples, such as liquids, is oftendeterminedby thecalorimetricmethod(Richner etal, 2010). Calorimeteris a toolthat oftenusedto measurechanges of heat duringchemical reactionstake place. Calorimetertoolscommonlyusedin the laboratoryisflaskorcup calorimeter. The principle ofthisinstrumentis to measure thechanges of temperature of reaction andestimation of capacity ofheat can beusedto estimatetheheat ofreactionwell(Rufiati, 2011).

The flask calorimeteris oftenusedasthe toolbecause it is easy to useandnottooexpensive. Observations of temperaturewerecarried outonthe devicemanuallyorwith thenakedeye, so it is

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likelythe dataobservationsare lessscrupulous. Thereforeinthis research, we make modificationsto thetoolof observation of temperatureusinga digitalmicroscope.

The purposeof this studyis to determinethe level ofresolution ofthe temperaturewith a thermometerreadingsmonitoredwithregulardigitalmicroscope, to determine the effectof temperature on thevalue ofCpcalorimeterandto determine the feasibility ofthe calorimeterismade todetermine theenthalpy ofneutralization.

2. Experimental

2.1 Reagents

All chemicals were of reagent grade. The deionised water (Millipore, Bedford, MA, USA) was used throughout the experiments.Stock solutions (0,5molL^{-1}) of oxalate were prepared from their potassium salts.Stock solutions (0,5mol L^{-1}) of HCl were prepared from concentrated HCl 37% Stock solutions (0,5mol L^{-1}) of NH_4Cl oxalate were prepared from their ammonium salts.

2.2 Apparatus

The schematic diagram of simple Calorimetr with digital microscope is shown in Fig. 1.Calorimeterconsistsofacupstyrofom, alcoholthermometer, stativeanddigitalmicroscope. Styrofomis used formixingthe reactants. Type of digital microscope is Dino-Lite ProAM413.Digitalmicroscopeis placedadjacent to thethermometer. Thismicroscopeis used tomonitor changes intemperaturecausedbyendoterm oreksoterm reaction.

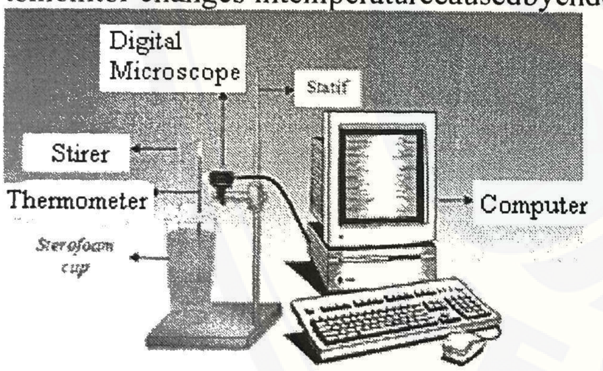

Fig. 1. Simple Calorimeter with digital microscope configuration

CalorimeterDesignwithDigitalMicroscope.

Digitalvideoretrievalis done byrecording thevideofroma digitalmicroscopethatfacedthermometerin thecalorimeterforreadingtemperature. Then thevideois processedwithLabVIEW8.6softwareprogram. This study used alineprofilewhichproducesgraphsthat provide the relationshipbetweentime(x-axis) with theRGBvalue(y-axis). Measurements were madeby drawinga lineon thepicture of fluid(red color) on thethermometertocalculatethe number of pixelsonthe longAandB, .as shownin Figure2. changes of temperature arevisibleon the screenthat can bedeterminedbythe relationship:

$$\text{Temperature} = 25^{0}C + \frac{\sum \text{B piksel}}{\sum \text{A piksel}} \times 1^{o}C$$

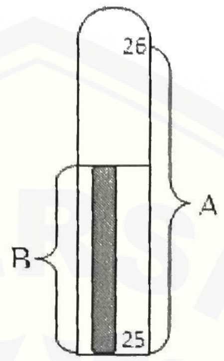

Fig2. reading of temperaturescale

Description:
A=Number of pixels that have been determined
B=Number of pixelsareread

Determination of Cp Calorimeter.

Determination of Cpcalorimeteris used tocomputethe value ofthe heatcapacity ofthe calorimeterapparatus. ValuesCp of calorimetermeasurement follow in this procedureas: 50.0mL ofdistilled wateris incorporated into thestyrofoamcup. Click theRunbuttontostart recording, then immediatelyadd50.0mL ofdistilled waterthat has beenheatedtoa fixed highertemperature(1°C). recordingof temperaturestops automatically, then theinitialtrialcan beterminatedby pressing thestop button. Recorded datawas analyzed usingLabView8.6TMsoftwareto determine the valueinitialtemperaturedandfinal temperature.

Calorimeterspecific heatcan be determinedby the formula:

$$C_{cal} = \frac{m_{hot.wt} \times c_{wt} \times (T_{hot\ inial} - T_{final}) - m_{col.wt} \times c_{wt} \times (T_{finap} - T_{col.init})}{(T_{final} - T_{cool.init})}$$

Testingof Feasibility of Calorimeter

A total of50.0mLof HCl solutionis incorporated into thestyrofoamcup. Click theRunbuttontostart recordingthe temperatureof HCl, then immediatelymakethe additionof

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50.0mLof NaOH solutiontotheStyrofoamcup, beforeNaOH solutionwas measuredat a temperature of25 ° C, thenthe solution wasstirredwith astirrer. Results ofthe recordingwillstop automaticallyandcan beterminatedearlyexperiments. Recorded datawas analyzed usingLabViewsoftware8.6TMtodetermine theinitial temperatureandthe final temperature. Repetitionswas performed3 timesformeasurement of temperatureof solution reactionwith variousconcentrations of0.15and0.10M.Measurementswere also made tothe reactionsolutionof NaOH solutionwithNH4ClandHClwithNH4OHwith variousconcentrations of0.15and0.10M.Reactionenthalpyvaluescan be calculatedusing the equation:

$$\Delta H = -\left[(m_{solt} \times c_{solvennt} \times \int_{T_1}^{T_2} dT) + \int_{T_1}^{T_2} C_{cal}\, dT \right]$$

Determination of NeutralizationenthalpywithHess's Law.

Determination of reaction enthalpycanalsobe doneby combining thestandardenthalpy ofreaction-individualreactionsusingHess's Law. Heat ofreactiononly depends onthe initial state(reactants) andfinal state(products) . It does notdependon thecourse of the reaction.

Determination ofthe reactionenthalpy of compound$NH_4Cl$is donebycombining severalreactions. The firstreaction ofa solution ofNaOH(aq) is reactedwithHCl(aq) and thengive ΔH_1. The secondreaction,solution ofNaOH(aq) is reactedwith a solution ofNH_4Cl(aq) andΔH_2 determined, thenboth the value is summed. Enthalpy of reaction of compoundsNH_4Cl can also becounted on onestagewith a solution ofHCl(aq) that is reactedwith a solution ofNH_4OH(aq) and thenΔH_3 is determined. Thermochemicalequationcan be seenin Table1.

Table1. Thermochemicalequation

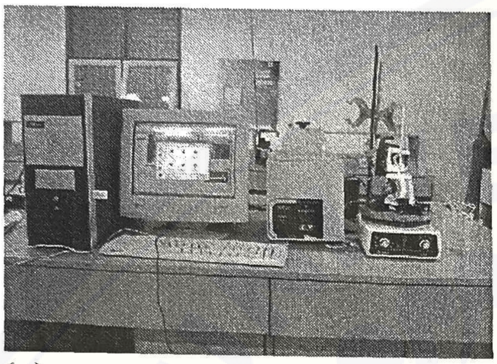
ΔH	Thermochemicalequation	ΔH (kJ/mol)
ΔH_1	$NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$	-56,3
ΔH_2	$NaOH(aq) + NH_4Cl(aq) \rightarrow NH_4OH(aq) + NaCl(aq)$	-0,5
ΔH_3	$HCl(aq) + NH_4OH(aq) \rightarrow NH_4Cl(aq) + H2O(l)$	-55,8

(Lide, 2004).

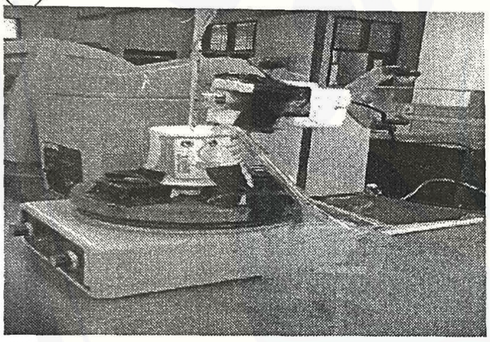
Discussion

SimpleCalorimeterDesignis Monitored with Digital Microscope

This research resulted inasimplecalorimeterdesignsbeing monitoredbydigitalmicroscopy. Thecalorimeterconsistsof aseries ofstyrofoamcup, thermometer, digitalmicroscope, stirrerandcomputers. The onethathas beencreatedcan be seenin Figure3.



(a)



(b)

Fig. 3. a set of simpleCalorimeterwithDigitalMicroscope: (a) overall of a setcolorimetersanddigitalmicroscope(b) a set ofcolorimeteranddigitalmicroscopeviewed fromside

Programs used inthermometerscalereadingsis madewithLabview8.6software. The programfeatured front-panel anddisplaytheblockdiagram. Frontpanel show thedisplay of monitorduring the process, while theblockdiagramis alogicfunctiondesignof workoftheprogramhave been made. Displayof the front panelandblockdiagramfor analyzing oftemperature readingon video can be seenat Figure4and5.

Images capturedby adigital microscopeare transferedinto aPersonal Computer(PC) and then storedby thePersonal Computer(PC). Videoresultsobtainedwill beprocessedby theprogramLabViewTM8.6automatically. The result ofthevideoimageson the displayis drawnby a lineso that we getgraphs that state relationship of timewiththe number of pixels.

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The lengthof the line betweenA andBin Figure4represents thenumber of pixelsgeneratedfromthe movement offluid(red color) on the thermometerwhenthe temperature changestake place. The number of pixelsin range A- B is inserted into blockdiagramin programfor microscope(Figure5)andfound the number ofpixels onthe line ofA-B(the units of degrees) as much as447pixels, so thechange of temperature inlengthcan be known the numberof pixels.

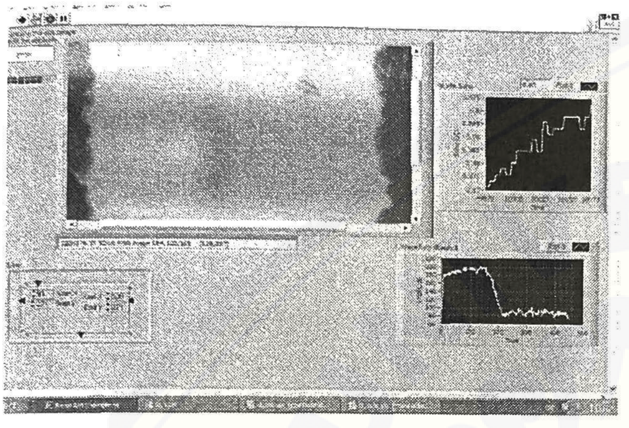

Fig4. display of Frontpanelfor readingthermometer scale

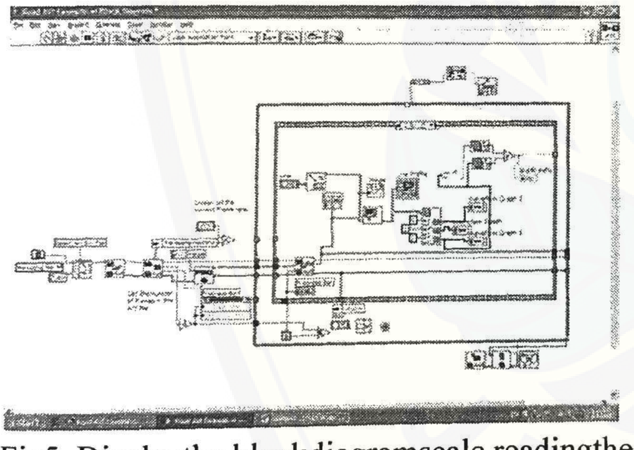

Fig5. Displaythe blockdiagramscale readingthermometer

DeterminationFunctionOfTemperatureCalorimeterCp.

Heat capacity atconstantpressure(Cp) is usedto find the valueof theheatof absorptionof calorimeter. Heat capacitywill be usedtoconnect theenthalpychangeswith temperature changes. The results ofthe graph in Figure6showsthatCpis a function oftemperature. It means thatvalue Cp change withchange of temperaturein solution.

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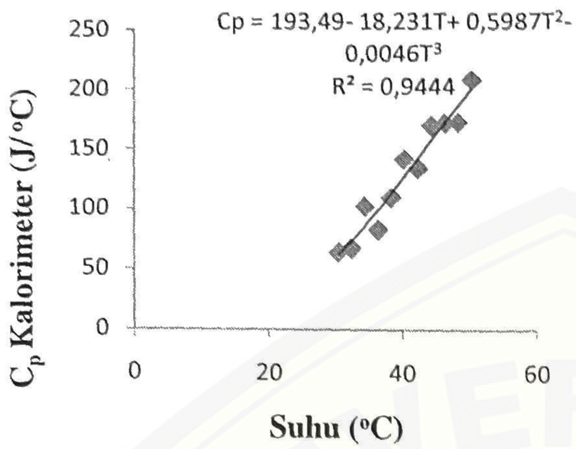

Fig6. Relationshipof graphCpcalorimeterwithtemperature

The results ofthe graph in Figure6showsthat theequationCpisa function of temperature. Cpequationsused are3types ofpolynomialequations, namely, itcan be seenapproachingthe value ofthe enthalpy ofthe testresultswiththe literaturevalue ofthe enthalpy. This equationshowsthat theheatcapacity ofthe calorimeteris affectedby changeof temperatureinthe measuredsolution.

Accurationand Precision ofDesain of simple Calorimeter withDigital Microscope.

Accurate resultsis theresult of agreement to thetrue valueinameasurement of the quantity(Khopkar, 1990). Determination ofaccuracyinthis studywas done by comparingthe value ofthe enthalpy ofthe testresultswiththe literaturevalue ofthe enthalpy. Accuracy resultsbetween thereactionof NaOHwithHClandHClreactionwithNH4OHat concentrationsof 0.15and0.1Min Tables2and3showthat the resultsof theaccuracyis good. Itmeans thatenthalpyvaluecloseto the value ofthe enthalpy ofthe literature. This result isin contrast tomeasurements ofthereaction ofNaOH with NH_4Clin Tables2and3which show the results ofaccuracy isless than theaccuracy ofthesamplereactionwithHClandNaOHreaction ofHClwithNH4OH. Results ofthis datadueto thevalue ofthe enthalpy ofreactionof NaOHNH_4Clata literatureis smallthat is equal to0.5kJ/mol. Itmeans thatthe heat releasedisless likely tochange oftemperaturethat occursbeing very small, so thatthe readingon the thermometerwith adigitalmicroscopeis still notable toreadtheconditions oftheenthalpywith valuesbeingverysmall.

Valuesof accuracycomparedwithcalculationsbased onthe literatureat theconcentrationsof 0.15and0.10MinTables 4 and5showthe results ofaccuracy isless than thevalue ofaccuracyineachreactionin Table2and3, it is influencedbythe sumwhich thereactionenthalpyvaluesis farfrom theliterature.

Table2. Comparison ofthe accuracy ofthe enthalpy ofa simplecalorimetertest resultsweremonitoredwith adigitalmicroscopewithliteratureat a concentrationof 0.15M.

Sampel	Akurasi

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	(%)
$NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$	99,4
$NaOH(aq) + NH_4Cl(aq) \rightarrow NH_4OH(aq) + NaCl(aq)$	6,9
$HCl(aq) + NH_4OH(aq) \rightarrow NH_4Cl(aq) + H_2O(l)$	99,0

Table3. Comparison ofthe accuracy ofthe enthalpy ofa simplecalorimetertest resultsweremonitoredwith adigitalmicroscopewithliteratureat a concentrationof 0.10M.

Sampel	Akurasi (%)
$NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$	98,3
$NaOH(aq) + NH_4Cl(aq) \rightarrow NH_4OH(aq) + NaCl(aq)$	11,5
$HCl(aq) + NH_4OH(aq) \rightarrow NH_4Cl(aq) + H2O(l)$	98,0

Dataof analysis of precision testsamplesin Tables5and6is the coefficientof variationofthreerepetitions, whereKvvaluesindicatethe level ofmeasurement errordue torepetition. Precisionresultsobtainedat a concentration of0.15Mand0.10Marebelow5% as shown in Table5and6. Theresultshavea highprecisionlevelmeasurement errordue tomeanlittlerepetition.

Table4. Accuracy results$\Delta H_1 + \Delta H_2$ are comparedwith ΔH_3

Konsentrasi reaktan	**ΔH (kJ/mol)**	**$\Delta H_1 + \Delta H_2$ (kJ/mol)**	Akurasi (%)
0,15 M	-56,37	-49,45	87,7
0,10 M	-54,69	-51,05	93,3

Table5. Precisionanalysis ofdatasamples atconcentrations0.15M

Sampel	Kv (%)
$NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$	1,199
$NaOH(aq) + NH_4Cl(aq) \rightarrow NH_4OH(aq) + NaCl(aq)$	2,993

$HCl(aq) + NH_4OH(aq) \rightarrow NH_4Cl(aq) + H_2O(l)$	3,174

Table6. Precisionanalysis ofdatasamples atconcentration 0,1 M

Sampel	Kv(%)
$NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$	1,602
$NaOH(aq) + NH_4Cl(aq) \rightarrow NH_4OH(aq) + NaCl(aq)$	3,227
$HCl(aq) + NH_4OH(aq) \rightarrow NH_4Cl(aq) + H_2O(l)$	2,734

Conclusion

Value of resolutionfor reading temperature onthe thermometerina simplecalorimeterthat ismonitoredwith adigitalmicroscopeis 0,002°C, whilereadingthemanualis only0.5°C. EquationCpobtained by thecalorimetershow thatCpis a function oftemperature, It meanthat Cpvalueschange withchange of temperatureina solution. Value ofaccuracy resultsin a samplehas alargeenthalpyvalueobtainedat the differentvaluesof theaccuracywithsmallenthalpyvaluethat haslittleaccuracy. Accuracy ofthe testresults ofthe comparisonof resultswith theliterature is conductedat concentrationsof 0.15Mand0.10Mrespectively99.4% and98.3% forthe sample, 6.9% and11.5% forthe sample, and99, 0% and98.0% forthe sample. Value ofprecisionat a concentration of0.15Mand0.10MshowedKvvaluesbelow5%, so theprecisioncan besaid to begoodvalue.

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