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Differential scanning calorimetry study of ordinary Portland cement paste produced from two different cement plants

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The lack of data on physicochemical parameters of cement made in our country (Algeria) led us to undertake this work, it is to observe two different cements, one product at the "Meftah" cement plant and the other at the "Rais-Hamidou" cement plant, and proceed to their thermal analysis with differential scanning calorimeter DSC 6 of Perkin-Elmer. The evolution of temperature is carried out in linear programming. We put in highlight the evolution of the average enthalpy and the average specific heat depending of w/c (water/cement ratio**),** and the influence of speed of heating on this evolution.

1. Introduction

Cement is flexible hydraulics which, when produced, is presented in the form of very fine powder. Mixed with water it makes taken and hardens. Its raw material is made up to limestone 80% and Clay 20% (Silico Aluminates) ,however, additions of the iron (Fe_2O_3) and of bauxite ($Al_2 O_3$) are introduced to reach the desired composition. When a material undergoes a physical change of state such as a fusion or an allotropic transition or, if it reacts chemically, heat is implemented, these processes can thus be initiated in experiments by rise or fall in temperature at the laboratory.

2. Experimental procedure

Preparation of the samples with ratio E/C *is* done as follows*:*

- To mix the adequate quantities to obtain the paste.
- To take from the paste, a sample (whose mass should not exceed 10 mg)
- To deposit the sample in a pastille of Aluminium whose should be crimped (using a suitable mechanic press).

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- To install the pastille in the enclosure of the furnace of the DSC.
- To choose the program of temperature which we want to carry out by fixing all the parameters
- To launch the program of heating.

2.1 Experiments

We carried out two series of experiments in linear programming of heating as follows:

1st series:

- Range of temperature:20°C to 200°C
- Speed of heating 10°C/mn
- Water solid ratio; E/C = 0.2 to 0.8 with a step of 0,1.

2nd series:

- Range of temperature: 30°C to 300°C
- Speed of heating: 20°C/mn
- Water solid ratio : E/C =0.2, E/C=0.3, E/C= 0.5, E/C= 0.8

3. Results and Discussion

3.1 Variation of the enthalpy and of the specific heat of cements depending of E/C with a heating rate of 10°C/mn

Results of the first series of experiments allow us to study the evolution of the enthalpy and of the specific heat

Table.1 Results of the first series of experiments

Water solid ratio E/C	ΔH (J/g) R-H Cement	ΔH (J/g) Meftah Cement	ΔCp (J/g.°C) R-H Cement	ΔCp (J/g.°C) Meftah Cement
0.2	93.626	50.893	4.308	8.513
0.3	130.587	52.445	8.909	8.069
0.4	99.82	65.222	4.45	8.923
0.5	425.908	142.838	105.914	15.115
0.6	96.717	103.325	12.578	5.187
0.7	309.988	471.047	25.045	31.422
0.8	207.9	257.438	23.887	22.08

Results of the first series of experiments allow us to study the evolution of the enthalpy and of the specific heat according to report/ratio E/C for each Cement.

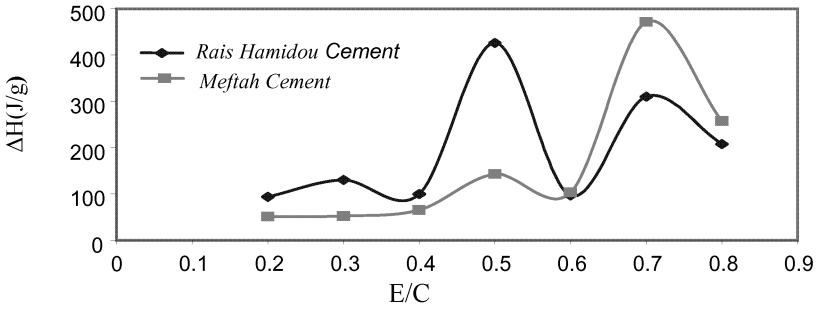

Fig.1: Variation of the enthalpy depending of E/C
Heating rate: 10°C/min

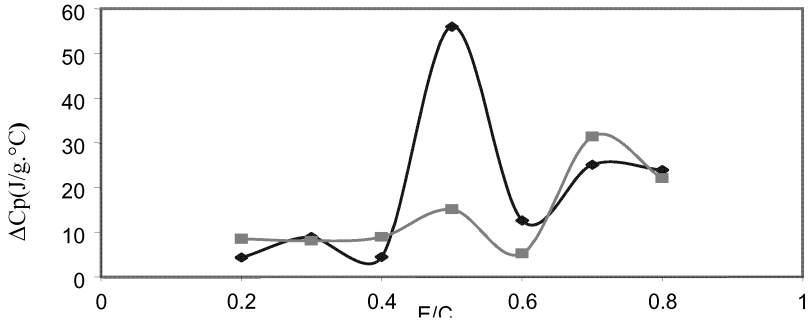

Fig. 2: Variation of the specific heat depending of E/C
Heating rate: 10:°C/min

3.2 Discussion

It is noted that the curves of ΔH = f (E/C) and ΔCp = f(E/C) evolve in the same way for our two cements but with notable differences in the intensities This is due to our opinion to the difference in their mineralogical composition and additions used during their manufacture

These differences in composition of the two cements which must be added the difference in their fineness of grind (S.S.B) greatly affect the heat of hydration and therefore the specific heat

3.3 *Variation of the enthalpy and the specific heat of the two cement depending of E/C with a heating rate equal to 20 ° C / min*

The results of the second series of experiments also allow us to study changes in enthalpy and the specific heat depending of E/C with a heating rate of 20 ° C/min, for each cement.

Table .2 Results of the second series of experiments

water solid ratio E/C	ΔH (J/g) R-H Cement	ΔH (J/g) Meftah Cement	ΔCp (J/g.°C) R-H Cement	ΔCp (J/g.°C) Meftah Cement
0.2	28.019	92.661	0.964	1.83
0.3	115.167	109.722	1.764	2.175
0.4	116.233	202.902	3.161	4.068
0.5	111.254	332.238	2.258	3.548
0.8	3466.85	553.143	93.622	13.331

The graphic representation of this evolution is given in Figures 3 and 4 below

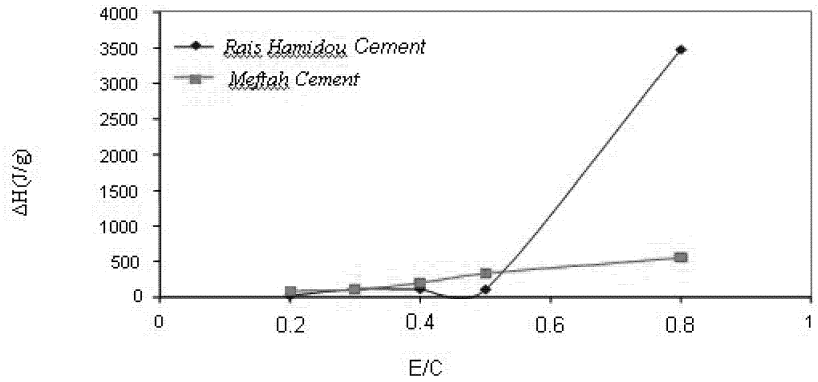

Fig.3: Variation of the enthalpy depending of E/C Heating rate: 20°C/min

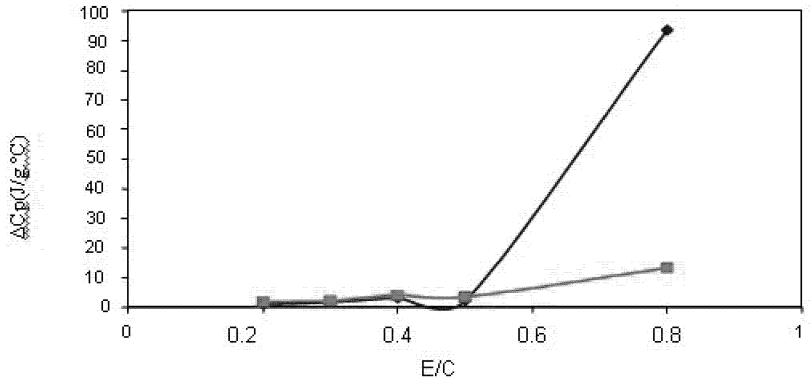

Fig.4: Variation of the specific heat depending of E/C Heating rate: 20°C/min

Conclusion

In both sets of experiments, it has been highlighted enthalpy and the specific heat, the results showed significant differences in their respective behaviour. This is due to our opinion in the difference in the mineralogical composition of the two cements studied and their raw materials and the difference in their fineness of grind (S.S.B)
Has been highlighted the influence of the heating rate on the evolution of the enthalpy and the specific heat

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