Chemical Specifications for Raw Materials Used in the Kufa Cement Industry in Iraq

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***Abstract*— The aim of this paper is to provide background information on raw materials included in the cement industry that have been chemically examined in the laboratories of the Kufa Cement Factory in cooperation with AL-Furat Al-Awsat Technical University, Najaf Technical engineering college, Najaf, Iraq. The raw materials entering the factory were examined, which include stone, crude oil, iron dust, sand, and gypsum, as it was found that the total carbonate ratio is 89% as a weight ratio and the sulfide is smaller or equal to 1% as a weight ratio and the magnesium carbonate is smaller or equal to 3%. For iron dust with sand, the total carbonates of the mixture were smaller or equal to 85%, and magnesium carbonate was smaller or equal to 3%, and silica oxide was also examined in sand where the results of the examination were greater than 85%, and for sulfide oxide smaller than 1%, as well as for iron dust, the proportion of oxide Ferric is greater than 55%, the percentage of alumina oxide is less than 10%, silica oxide is less than 20%, as well as for crude oil, as it contains less than 4% of sulfide oxide, as well as primary and secondary gypsum examination, and it was found that sulfide oxide is greater than 31% if the gypsum is Secondary and greater than 42% if the gypsum is primary and Materials are non-soluble smaller than 8% if it was a secondary gypsum and less than 5% if the primary gypsum. Where these models were examined and analyzed, and the storage location of the models examined was determined.**

Keywords- Chemical, raw materials, Kufa Cement, laboratory, gypsum.

I. INTRODUCTION

Kufa Cement Factory is one of the formations of the General Company for Southern Cement of the Ministry of Industry and Minerals. This factory is located in Iraq in the province of Najaf / Kufa District This plant was established in 1977 by the Danish company and the number of production lines 4 and production 1781000 tons annually and works in the wet way as well as the production of clinker 1728000 Tons per year as the produced cement is in conformity with the basic specifications and standards of the Ministry of Industry and Minerals as well as applying a quality system in accordance with international standards (2008 - ISO 9001). The Kufa Cement Factory has an important role in informing the reconstruction process by providing Iraq from the north to the south with cement material and the location of the Kufa Cement Factory in the Najaf governorate has been chosen because of the abundance of raw materials of high quality that are included in the cement industry where stone quarries are located near the factory in the Najaf sea area As well as dirt quarries located in the Kifl and Dahisia regions, the factory produces ordinary Portland cement and salt-resistant [1].

Cement is any substance which binds together other materials by a mixture of chemical processes known collectively as setting. Cements are dry powders and will not be confused with concretes or mortars, but they're a crucial constituent of both of those materials, during which they act because the 'glue' that provides strength to structures. Mortar may be a mixture of cement and sand whereas concrete also includes rough aggregates; because it's a serious component of both of those building materials, cement is a particularly important construction material. it's utilized in the assembly of the various structures that structure the fashionable world including buildings, bridges, harbours, runways and roads [2]. it's also used for facades and other decorative features on buildings. Demand is constantly increasing, increasingly from the Middle East, and thus cement is among the most consumed commodities after water [3]. We often consider cement used in construction Either hydraulic or non-hydraulic, depending on the strength of the cement in the presence of water. Thus, the non-hydraulic cement will not be placed under water or in wet conditions; instead, it will be adjusted because it dries and reacts with carbon. Dioxide in the air. It are often attacked by some aggressive chemicals after setting [4].

Hydraulic cements (e.g., Portland cement) set and become adhesive thanks to a reaction between the dry ingredients and water. The reaction leads to mineral hydrates that aren't very water-soluble then are quite durable in water and safe from chemical attack. this enables setting in wet condition or underwater and further protects the hardened material from chemical attack. The chemical change for Portland cement found by ancient Romans used volcanic ash[4] . Six samples were taken from limestone (Bahr Al-Najaf region) and four samples from clay materials (Kifl region), where the results showed an increase in the magnesium oxide content. As for clay materials, the silica content was high, while the content of alumina and iron trioxide was relatively low[5]. The chemical composition of cement depends mainly on the raw materials involved in the manufacture of cement. Knowing the chemical composition gives preliminary information about its quality

and suitability for the cement industry. Moreover, some components such as magnesia, sulfates, alkalis and chlorides that cause problems in the process of operating in the oven should be taken into account[6]. The health and environmental pollution risks due to the cement industry must be taken into consideration because the cement is one of the heavy industries and is concerned about environmental pollution and the risks of workers and residential areas adjacent to the factory[7]. Therefore, this current work was done to create a database for the specifications of raw materials (stone - sand - iron dust - crude oil - gypsum) that are used in the Kufa cement industry in Iraq to benefit researchers who work in developing this field.

II. RAW MATERIALS MINING

The first step in making cement is in the raw materials and grouping them together so that the required chemical composition is reacted by the heat produced from the furnaces. In order for the reaction to complete well, the raw materials used in the cement industry will be ground. Mixed with each other, prepared for the oven, and the ground materials are heated to extremely high temperatures [8].

Since the ultimate composition and properties of cement are specified within rather strict bounds, it'd be supposed that the wants for the raw mix would be similarly strict. because it seems , this is often not the case. While it's important to possess the right proportions of calcium, silicon, aluminum, and iron, the general chemical composition and structure of the individual raw ingredients can vary considerably. the rationale for this is often that at the very high temperatures within the kiln, many chemical components within the raw ingredients are burned off and replaced with oxygen from the air. Table 1 lists just a few of the various possible raw ingredients which will be wont to provide each of the most cement elements[8].

TABLE I. RAW INGREDIENTS USED TO PROVIDE EACH OF THE MAIN CEMENT ELEMENTS[8].

Calcium	**Silicon**	**Aluminium**	**Iron**
Limestone	Clay	Clay	Clay
Marl	Marl	Shale	Iron ore
Calcite	Sand	Fly ash	Mill scale
Aragonite	Shale	Aluminium	Shale
Shale	Fly ash		Blast furnace dust
Sea shells	Rice hull ash		
Cement kiln dust	Slag		

The cement industry is taken into account of strategic industries. it's so simple with the industry compared to major industries, and depend upon the supply of the required raw materials for it. The basic mixture of cement industry consists of [9]:

- gypsum.
- lime stone.
- Clay.
- Calcium carbonate.
- Silicon oxide.
- Aluminum oxide.
- Iron(II) oxide.

III. DESCRIPTION OF RAW MATERIALS OF CEMENT

A. Gypsum

Gypsum is a white limestone or fine grained. It consists of calcium carbonate. Mud and quartz are the most common impurities. Most gypsum is soft, friable rock that does not require explosives in mining [10].

Gypsum material, which is called aqueous calcium sulfate, is brought to the Kufa Cement Factory from the quarries of Anbar Province in Iraq because of its quality, but after the distance was one of the difficult challenges, so there was an alternative to these quarries, where exploration was carried out in Najaf because of its proximity to the factory and found material Primary and secondary gypsum included in the cement industry Gypsum material is an important primary material added to cement in the penultimate stage with 3% of clinker where the acceptable mixing limits for sulfide oxide are from 31% to 40% for secondary gypsum and primary gypsum from 40% to 44% and the materials Insoluble from 5% To 11% if the gypsum is secondary and from 3% to 6% if the gypsum is primary and rejection is in the presence of a percentage of sulfide oxide higher than 30% for the secondary gypsum and also if the sulfide oxide ratio exceeds 43% for the primary gypsum and is rejected in the event that the proportion of non-receptive materials increases The solubility is about 8% for the secondary gypsum and more than 6% for the primary gypsum. Thus, the gypsum is rejected if it does not achieve the mixing limits accepted above and is replaced by a good quality for the purpose of mixing.

B. Limestone

Limestone is one of the main materials involved in the manufacture of cement and is in the form of extensive deposits, covering hundreds of square kilometers, and is relatively different in thickness and quality. Therefore, limestone material can be large and long-lived, mining limestone layers that can be hundreds of feet thick over areas of several square kilometers. Many mines produce multiple products, and crushed rocks may remain impure enough for certain uses suitable as road heaps. Thus, limestone is brought from quarries owned by the Kufa Cement Factory which is 35 km away from the factory and then transferred to crushers for crushing and transported by the rubber conveyor and then stored in the factory warehouses and transferred to the mills feeding area and before that it is examined laboratory before it is sent to the feeding area and there are limits Mixing for calcium carbonate from 85% to 98%, mixing limits for sulfide oxide from 1.5% to 0.5%, mixing limits for magnesium carbonate from 1.5% to 5%, thereby rejecting the primary material (lime stone) if the carbonate ratio Calcium is less than 85%, and if the percentage of sulfur oxide was Greater than 1.5%, and if the proportion of magnesium carbonate is greater than 3% and thus be withdrawn models that I said or abounded confused about the above borders and isolate and re-send replaced by good qualities for the purpose of mixing . The amount of limestone or calcium or silica, alumina and iron oxides should be in known proportions to produce cement

because the increase in the amount of limestone causes clinker formation early and thus a decrease in temperature and thus affects the chemical reaction process and the combination of silica and alumina that need high temperatures [11].

C. Clay

Definition and uses: It is a basic material used in the manufacture of cement, and it is a soft material that is mainly aqueous alumina silicate (Al2Si2O5) (OH), it contains 23.5% alumina, 46.5% silica and is used in the manufacture of white ceramics and in the packing and coating of paper. It is also used as a filling material in Paints, rubber, plastics and many other products[10]. Where the proportions of aluminum oxide and silicate differ according to the type of clay. As the clay material has an important role in the manufacture of cement that is mixed in certain proportions with other materials used in the manufacture of cement, such as limestone, iron dust and other other materials involved in the manufacture of cement. Where the Kufa Cement Factory intentionally brought the finest clay from Al-Diwaniyah Governorate from Al-Dahisia district, which is 50 km from the cement factory, which contains 15% soil and is chosen by the Geological Survey Department of Al-Diwaniyah Governorate. The dirt in the mud contains 42% of silicon oxide. The moisture content of the clay material must be less than 55%. Where the acceptance limits for the clay material are from 45% to 57%, so that if the humidity exceeds 57%, it is preserved and the amount of water added to the soil is reduced. Then it is transferred to the clay crusher, and the mixing ratio is from 55% to 60%. The soil in the clay also contains iron oxide by 5.5%, calcium oxide by 18%, magnesium oxide by 5% and sulfur dioxide by 1% and also contains alkali with a very difficult ratio, which is potassium oxide and sodium by 0.2%, and these ratios are approved from Before the Iraqi Quality Evaluation and Control Authority used in the manufacture of Kufa cement in Iraq.

IV. RESULTS AND DISCUSSION

Laboratory results obtained for the raw materials used in the manufacture of cement material for the period from 1/1/2020 to 1/31/2020 within the laboratories of the Kufa Cement Factory in Iraq in cooperation with the Technical Engineering College in Najaf. As the raw materials play an important role in the quality and stability of the product, the raw materials should be of close, non-fluctuating specifications. Whereas, the chemical (laboratory) requirements for the raw materials needed to produce cement, as the required limits for the magnesium carbonate present in the limestone are smaller or equal to 3% compared to the value obtained through laboratory testing was 0.77% . As the required value for sulfate in limestone is smaller or equal to 1%, while the value obtained in the laboratory was 0.79%. While the value of sulfates in sand was smaller or equal to 1% as a required value, since the value obtained laboratory is 0 .98%, and for gypsum, the required value is greater or equal to 31% of sulfates, while the value obtained laboratory for sulfates It was 32.16%. While the required value for silica in limestone is smaller or equal to 5%, compared to the value obtained from the laboratory for silica is 2.23%. Likewise for sand material, the required value according to the required specifications is greater or equal to 85%, while the value that was Laboratory acquisition is 92.62%. With regard to triple iron oxide, the required iron dust ratio within the standard is greater or equal to 55%, while the value obtained through laboratory testing was 24.45%. Likewise with respect to triple aluminum oxide (alumina), the percentage of iron dust is smaller or equal to 10%, while the value obtained laboratory for alumina is 3.57%. As shown in the table below No. (2), which clarifies the values of raw materials used in the cement industry that were obtained in the laboratory.

TABLE 2. MONTHLY REPORT OF RAW MATERIAL FROM 1/1/2020 TO 31/1/2020.

Compound	Limestone	Clay	Iron	Sand	Kiln feed	Gypsum
SIO_2	2.23	39.90	9.86	92.62	13.34	
AL_2O_3	0.53	15.24	3.57	2.04	3.24	
FE_2O_3	0.29	4.94	75.24	0.78	3.40	
Mgo	0.77	5.25		0.08	2.20	
SO_3	0.79	0.48		0.98	1.09	32.16

Through laboratory results obtained laboratory for silica, alumina and iron trioxide as shown in Fig. 1, 2 and 3.

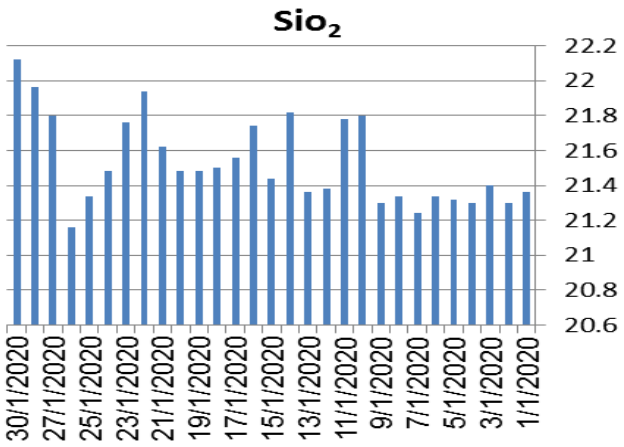

Figure 1. The amount of silica present in a month.

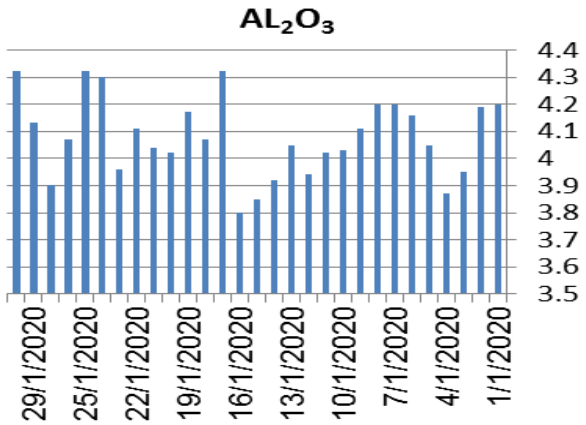

Figure 2. The amount of alumina present in a month.

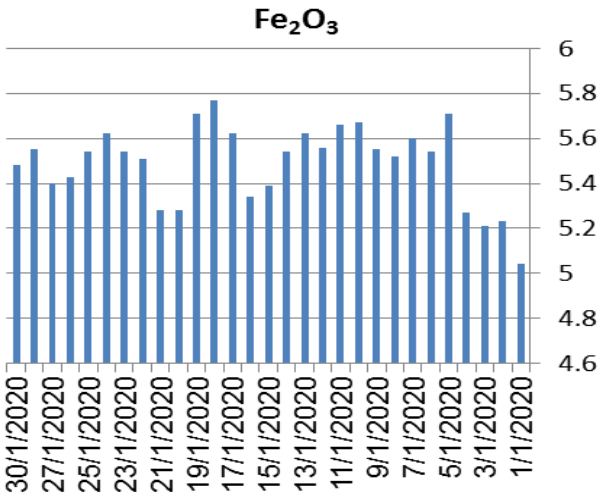

Figure 3. The amount of iron trioxide present in a month.

Through laboratory results, the impurities present in the raw materials and their effect on the production process, as the magnesium oxide present in the soil constitutes magnesium carbonate and at a constant rate, almost in the limestone, is variable and depends on how it is deposited as shown in Fig. 4 below.

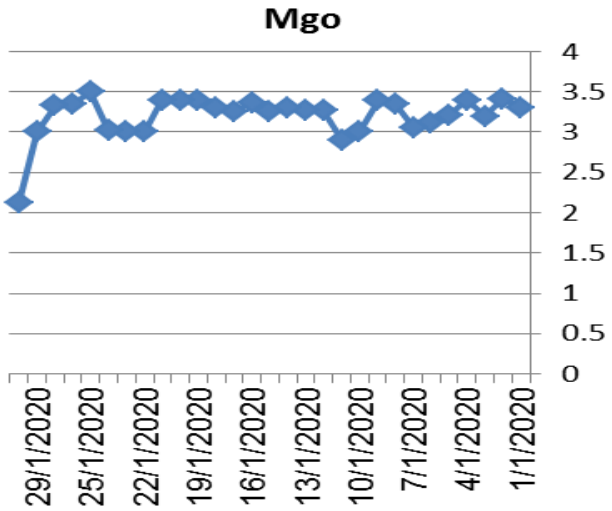

Figure 4. The amount of magnesium oxide present in a month.

Through the laboratory results obtained for a month, it was found that the impurities (sulfur oxide) that come from soil and limestone and that are in the form of calcium, sodium and potassium sulfate at a rate of no more than 1%, due to its negative impact on the consumption of the grinding bodies in the mills of the raw materials and on the consumption of Iron chains and backlit fans for furnaces and thus affect fuel combustion, as shown by the red points obtained during the laboratory examination within a month as shown in Fig. 5.

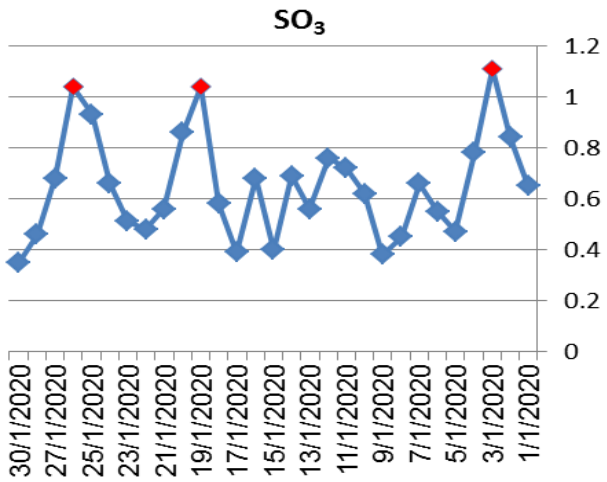

Figure 5. The amount of Sulfur trioxide present in a month.

V. CONCLUSIONS

The main conclusions that could be concluded from this paper are the following points:

- We conclude that the required percentage within the specifications of the evaluation and specific control device for magnesium carbonate is smaller or equal to 3%, while the ratio obtained laboratory is 0.77% and is considered within the required standard but is considered a low percentage, therefore it is preferable to find a better type of stone Limestone, which contains magnesium carbonate, is greater than 0.77% and does not exceed 3%. While the proportion of sulfate in limestone is good and within the required specification.
- The sulfate content in sand is an ideal ratio, as the laboratory value was 0.98%, while the required value within the established specifications is less or equal to 1%.
- The percentage of sulfate in gypsum according to laboratory tests was 32.16% , while the required ratio within the established specifications is greater or equal to 31%, and thus the gypsum material is considered good and acceptable in the manufacture of cement and within the specification.
- The percentage of silica in limestone that was examined in the laboratory was 2.23% , while the required percentage within the established standard is smaller or equal to 5% , and thus is considered within the standard, but with low rates, therefore it is preferable to find a better limestone and not exceed the proportion of silica in it 5% more.
- The sand entering the cement industry is considered an acceptable and good material, because it contains a percentage of silica 92 .62% that has been tested in the laboratory, while the required percentage within the established specification is greater or equal to 85% , and

thus the sand material is considered acceptable and valid in the manufacture Cement.

- The percentage of iron trioxide in iron dust should be the required percentage according to the established specifications is greater or equal to 55% , while the value that was examined laboratory is 75.24% , which is considered a good and acceptable percentage and thus iron dust is a good material in the manufacture Cement.
- The percentage of alumina in iron dust according to the required and approved standard is smaller or equal to 10% , while the value that was laboratory tested was 3.57% which is within the standard but is considered a low percentage, and therefore it is preferred that the percentage of alumina in iron dust be increased so that it does not It exceeds 10% within the required standard.
- The percentage of silica in clay according to the required standard should be in the range of (38% - 42%), while the value examined in the laboratory was 39.9%, thus the clay material is acceptable and valid in its use in the manufacture of cement.

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