# CHAPTER 5

## 5. SUMMARY AND CONCLUSION

Admixtures for concrete are defined as materials other than hydraulic cement, water, or aggregates that are added immediately before or during the mixing. Admixtures are added to modify the properties of fresh or hardened concrete in such away to be more suitable or economic for the job.

Chemical admixtures are classified into: water reducers, retarders, accelerators and superplastizers.

Admixtures are very important in industry because they increase the workability (water reducing agent), while other kinds increase or decrease the setting time which give more freedom for the transportation of the concrete or cement pastes.

In this investigation the MSF was prepared according to the four steps method. In this method the polymers were formed through (a) hydroxymethyltion of melamine by formaldehyde giving trimethylol melamine; (b) sulfonation of one methylol group of the product by sodium bisulfite giving sulfonated methylol melamine; (c) low pH condensation; (d) high pH rearrangement giving melamine formaldehyde sulfonate .

The MUSF was prepared by the same manner where the melamine molecule replaced by melamine/urea, (1/1) in the first step, then the sulfonation occurred in the second step. The product is undergoing low pH condensation and high pH rearrangement at the same vessel and conditions.

Cement pastes were made, using different admixtures dosages such as, 0.00, 0.25, 0.50, 0.75 and 1.00 mass% of cement. These admixtures were prepared in laboratory such as;

melamine sulfonate formaldehyde ($MSF_1$) (M : $SO_3$ : F; 1 : 1.22 : 2.58), melamine sulfonate formaldehyde ($MSF_2$) (M : $SO_3$ : F; 1 : 1.22 : 5.56), melamine sulfonate formaldehyde ($MSF_3$) (M : $SO_3$ : F; 1 : 0.4 : 1.4), melamine sulfonate formaldehyde ($MSF_4$) (M : $SO_3$ : F; 1 : 0.5 : 4) and melamine urea sulfonate formaldehyde (MUSF).

The water of consistency, initial and final setting time, rheological properties, electrical conductivity, compressive strength, bulk density, chemical combined water content, gel/space ratio, DTA and IR-spectroscopy were under taken.

The main conclusions derived from this investigation can be summarized as the following:

1- The reduction in the water of consistency increases in presence of different dosage of the admixture, this reduction was 33.33, 34.33, 14.33, 8.9 and 7.67% for 1.00% dose of ($MSF_1$), ($MSF_2$), ($MSF_3$), ($MSF_4$) and (MUSF), respectively. At 0.25 mass% dosage, the reduction in the water of consistency was 11, 6.67, 4.33, 1 and 2.23% for the above admixture respectively. All prepared admixtures act as water reducing agents.

In respect of initial and final setting time of cement paste admixed with melamine sulfonate formaldehyde ($MSF_1$), it is found that the initial setting time is retarded with the admixture content. The amount of the melamine sulfonate formaldehyde ($MSF_1$) reduces the final setting time, it acts as accelerating admixture and superplasticiser.

The initial and final setting time of the cement pastes using different dosages of melamine formaldehyde sulfonate ($MSF_2$) show retardation effect.

It can be concluded that the prepared ($MSF_2$) is retarding as well as water reducer.

The initial and final setting time are retarded by the addition of melamine sulfonate formaldehyde ($MSF_3$). Also, as the amount of ($MSF_3$) increases up to 0.50% the initial setting time is accelerated and then retarded at 0.75% and 1.00%. So, it is concluded that ($MSF_3$) is acted as retarder and water reducer. $MSF_4$ shows the same trend of ($MSF_2$).

The initial setting time is accelerated by the addition of melamine urea sulfonate formaldehyde (MUSF). As the dosage of admixture increases the initial setting time decreases. By increasing the amount of (MUSF) the final setting time is elongated. Also, it can be concluded that (MUSF) is acted as retarder and water reducer.

2- It is found that as the amount of admixtures increases the fluidity of pastes sharply increases. Also, it is found that ($MSF_2$) gives the highest fluidity of cement pastes at all dosages. This means that ($MSF_2$) is the optimum superplasticizer which gives higher fluidity of cement pastes than the other superplasticizers.

3- The combined water contents of the cement pastes increase with curing time for all admixtures dosages, due to the continuous hydration. As the amount of ($MSF_1$), ($MSF_2$), ($MSF_3$) and ($MSF_4$) increases the combined water content decreases, this is mainly due to the reduction of mixing water which effects the rate of hydration. 1.00% (MUSF) gives the highest combined water contents at all ages.

This means that 1.00% is the optimum dose of this admixture which gives higher rate of hydration but lower than the control cement sample.

4- The gel/space ratio of the cement pastes increase with curing time for all admixtures dosages. This is due to the increase of the amount of hydration products. Increase of the dosages of $MSF_1$ and $MSF_2$ the gel/space ratio increases. As the dosages of $MSF_1$ and $MSF_2$ increase the water of consistency and the total porosity decrease. $MSF_2$ gives higher gel/space ratio values than those with $MSF_1$, these results are in a good agreement with the amount of water reduction. The gel/space ratio of $MSF_3$ and $MSF_4$ decreases consequently the compressive strength values. 0.5% of $MSF_3$ is higher than 1.0%, this is due to the retardation effect $MSF_3$. As the hydration time increases the gel/space ratio increases up to 1.0 mass% at 90 days. At early ages (15 min up to one day) it was shown that the gel/space decreases with the amount of MUSF dosages. At later ages (3 days up to 90 days) it was shown that the gel/space ratio increases with the dosages of MUSF. This is due to the production of more dense and close-textured structure of the cement pastes.

5- The bulk density of the cement pastes increases with curing time for all admixture dosages. Obviously, as the amount of ($MSF_1$), ($MSF_2$), ($MSF_3$) and ($MSF_4$) increases the bulk density increases. Also, the 0.25% and 0.75% (MUSF) have higher bulk density than the other dosages.

6- The compressive strength of the cement pastes increases with curing time for all admixtures dosages. This mainly due to the increase of the amount of hydration products especially Tobermorite – like gel

(CSH). As the amount of $MSF_1$, $MSF_2$ and $MSF_4$ increases the compressive strength increases due to the decrease of the mixing water. The decrease in mixing water decreases the total porosity and improves the compressive strength. 0.75% $MSF_3$ gives the higher values of the compressive strength at all ages. As the content of $MSF_3$ increases the compressive strength decreases. 0.50% MUSF gives higher values of compressive strength than the cement pastes containing higher dosages. Therefore, 0.50% MUSF is the optimum values of MUFS to be added as a water reducer and accelerator. The increase of the dosage up to 0.5% retarded the hydration at early ages (1-3 days), due to the retardation effect of MUSF.

7- The change in the electrical conductivity reflects the physico-chemical changes in the cement pastes and it can be used to monitor setting and hardening processes. Significant changes in electrical conductivity occur when the paste gains its rigidity. On increasing the amount of polymeric materials, the conductivity maximum was found to have shifted to longer hydration times.