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Experimental Study on effects of magnetization on surface tension of water

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Abstract

Spray mist is the main means of dropping dust currently. It can not only settle the suspended dust in the air down, but also bond the adsorbed dust in the process of cutting surface. Effect of spray mist depends on the interaction between water mist particles and dust particles. The ability of water mist particles wetting dust particles or bonding them to the surface of water mist particles is stronger, and the effect of dropping dust is better. Strengthening the contact of dust and water mist, and keeping dust moisture is the key factor in improving the effect of spray mist. There are many factors related to the effects of water mist trapping dust, such as surface characteristics of water mist, size of spray mist particles, density of distribution, velocity, the time of water mist particles existing in the air and the physical and chemical characteristics of dust. Through laboratory determination, the effect of magnetization on surface tension of water was studied, and revealed the relevance of magnetic field tension, pipeline water flow, ionic-contained water and deionized water to the change of water surface tension.

Keywords-Magnetization; water; surface tension; related factor

1. Introduction

Dust is divided into hydrophilic and hydrophobic dust and the dividing standard can be dust wetting angle θ. When the wetting angle $\theta \leq 60°$, the dust can be called hydrophilic dust; when the wetting angle $\theta > 90°$, the dust can be called hydrophobic dust. In general, coal dust is mostly hydrophobic dust, and rock dust is mostly hydrophilic dust. This property has a great influence on the effect of dropping dust by spray mist. Because dust particle and spray particle contact in very short time, if reducing surface tension of spraying water, the ability to wet dust particle and the effect of dropping dust by spray mist can be increased. Magnetizing water, to a certain extent, can reduce the surface tension of water and improve water for dust wetting performance. Through comparing the surface tension of magnetized water and non-magnetized water, we can see this point.

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2. Experimental apparatus

Experimental apparatuses can be divided into three parts of water supply, magnetization and measurement.

3. Water supply

The water supply system can supply the water to the experimenter with different water quality and adjustable speed, as shown in Fig. 1. For accurate measurement, the system is set up with a flow volume device with 3 different ranges. The water tank is used for storing water of special quality. Experimenter can choose water in the tank or tap water according to different needs.

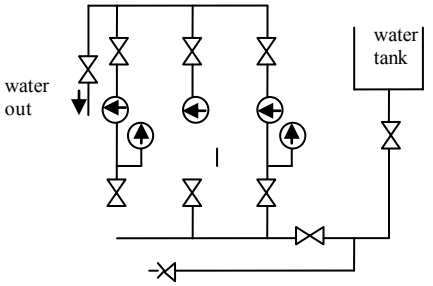

Figure 1. Water supply system

4. Magnetization

Magnetizing system has two forms with permanent magnet and electronic magnet. Permanent magnet is economical in actual application, while the electronic magnet can continuously adjust experiment [1]. We mainly use electronic magnet. The magnetizing system is as shown in Fig. 2.

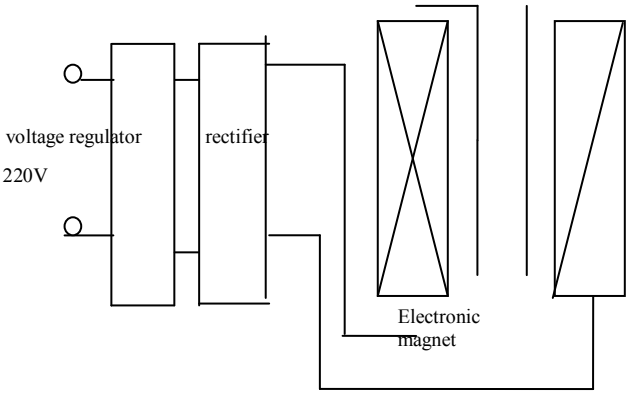

Figure 2. Structure of electronic magnetizing system

5. Experimental measurement of relation between magnetization condition and surface tension

The experimenter carried out a large number of tests on surface tension of magnetized water. Magnetization condition mainly refers to intensity of magnetic field, magnetic course, temperature, flow velocity and water quality. Because all of these factors can affect surface tension, for finding out the law,

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we have to fix parts of magnetization condition first and then select several terms to research. The experiment mainly researched the relationship between water surface tension and intensity of magnetic field for tap water and deionized water under different velocity.

6. The relationship between magnetic field and surface tension of tap water under different flow velocity

Measuring conditions: length between two magnetic pole is 40mm; magnetic course is 3×400mm; flow velocity is adjustable; intensity of magnetic field is 0~0.86T and adjustable. Under a specific flow velocity in the test, we can measure the relationship between water surface tension and magnetic field within a short time. The temperature fluctuation is less than ± 1℃ .The experiment can be completed in a few days; under different flow velocity, there exists a relatively large temperature fluctuation between 20℃ to 24℃ [2]. Therefore, the experimenter revised temperature for controlling the influence of temperature change on measurement within an acceptable range. The results of the experiment and data are shown in Table 1 and the data curves are shown in Fig. 3.

TABLE I. RELATIONSHIP BETWEEN TAP WATER SURFACE TENSION COEFFICIENT A （MN/M） AND MAGNETIC FIELD

Magnetic intensity /T	**Flow velocity /m.s^{-1}**					
	0.169	0.184	0.199	0.211	0.219	0.369
0.0	73.59	72.40	72.70	72.99	72.44	74.39
0.1	73.49	72.36	72.39	72.44	72.70	74.44
0.2	72.98	72.22	71.88	71.92	71.88	72.99
0.3	71.89	71.89	71.89	71.91	71.92	74.13
0.4	72.91	72.12	72.45	72.64	72.65	72.96
0.5	72.96	72.39	72.64	72.65	72.18	72.45
0.6	72.96	72.14	72.44	72.42	72.43	72.96
0.7	72.44	72.35	72.47	72.42	72.67	72.43
0.74	72.43	72.66	72.18	72.46	72.44	72.43
0.78	72.43	72.63	72.15	72.66	72.19	73.46
0.82	73.44	72.36	72.44	72.15	72.15	72.44

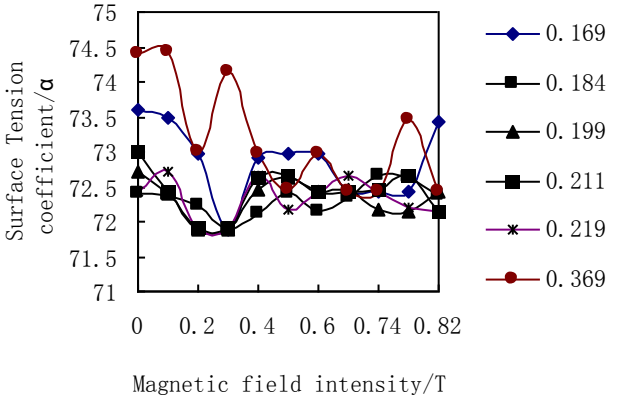

Figure 3. Data curves of tap water surface tension coefficient （mN/m） and magnetic field

7. The relationship between magnetic field and surface tension of deionized water under different flow velocity

The test condition is same with that of tap water and the result is similar .Test data is shown in Table 2, data curve in Fig. 4.

TABLE II. RELATIONSHIP BETWEEN DEIONIZED WATER SURFACE TENSION COEFFICIENT A （MN/M） AND MAGNETIC FIELD

Magnetic intensity /T	Flow velocity /m.s^{-1}		Magnetic intensity /T	Flow velocity /m.s^{-1}	
	0.13	0.18		0.13	0.18
0	72.97	72.38	0.5	72.47	72.39
0.1	72.96	72.37	0.6	72.47	72.13
0.2	72.45	72.13	0.7	72.47	72.39
0.3	71.44	71.87	0.74	72.25	72.66
0.4	72.47	72.16	0.82	72.97	72.39

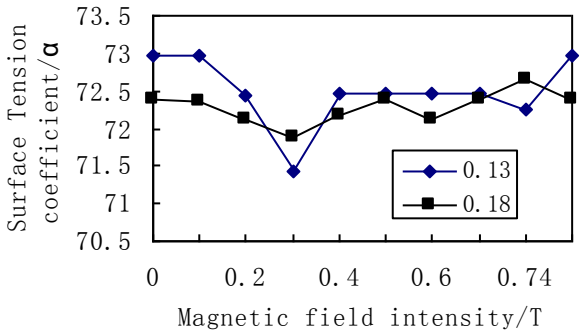

Figure 4. Data curves of deionized water surface tension coefficient a （mN/m） and magnetic field

8. Conclusions

To analyze the above data, we can get the following conclusions:

- After magnetization, the surface tension of both tap water and deionized water has declined. This shows that the role of magnetization on water surface tension is working through water molecules [3]. However, to the conclusion, we cannot rule out the effect of impurity atoms and ion which still needs to be discussed in further experiment.
- Water surface tension is related to intensity of magnetic field. When magnetic field is for 0.2~0.3T, there is a minimum of surface tension coefficient, showing the magnetization effect is for best and surface tension has dropped the most. With the increase of magnetic field intensity, surface tension curve begins to pick up. When magnetic field intensity is between 0.4~0.7T, surface tension curve approximates flat. The second minimum appears when magnetic field intensity is between0.7~0.8T, and this minimum is slightly larger than the first minimum. This phenomenon is similar with data in literature [4]. The intensity of magnetic field where the first minimum appears is identical with the optimum magnetic field intensity of domestic research [5].
- The experimental data obtained is measured under low velocity. When velocity is high, no clear relationship exists between surface tension and magnetic field. This is mainly caused by two factors. On one hand, the time of water in high - velocity flowing through magnetic field is too short for magnetization. On the other hand, under the high-velocity, water molecule collides heavily into chaos, which is also not easy for water to be magnetized. Literature [4] also display that under high velocity, the effect of magnetization is poor.
- The relatively-lower rate of surface tension is for 1%~ 2%, different from 10%~15% in literature [5], which is worth further study. According to the result of the experiment, understanding of magnetized water tends to hydrogen bond fracture process. In short, the best magnetic field intensity for magnetizing water is 0.2~ 0.3T, which exists certain differences from the past. In actual practice, magnetic field intensity should not be too high, otherwise it will not be able to reduce water surface tension.

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