Factors affecting the rheological characteristics of mud

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Introduction

The results of rheological tests from different researchers are quite different. The factors affecting the rheological characteristics include the density, particle size, and temperature, salinity. Moreover, the methods of test and analysis are also important factors to the difference, for example, the shear mode, the waiting time after the sample being inputted the rheometer, and rheological model as well. It is difficult to analyse the true reasons of the difference, and therefore, it is necessary to conduct rheological tests with the same methods and conditions on sediment samples collected from different ports.

Methodology

Equipment

Tests were conducted in laboratory using a rheometer with type of R/S-cc manufactured by Brookfield Company in America.

Sediment sample

Sediment was collected from different ports in China, including Tianjin south port, Lianyun channel and Xuwei channel of Lianyungang port, Yangtze Estuary channel in dry season and flooding season, Dachan Bay port area of Shenzhen port, Nansha port area of Guangzhou port, Zhuhai Power Plant port, Taishan Power Plant port. The average particle sizes of the sediment (D50) are smaller than 0.01mm, and the clay contents are larger than 30%, except for the sediment from Yangtze Estuary in dry season which average particle size is about 0.03mm.

Tests for the effect of temperature

In the tests for the effect of temperature, the sediment collected from Lianyun channel of Lianyungang port was prepared to be different density sample. The temperature of the samples in tests are controlled constantly with 2, 10, 20 and 30 ℃.

Rheological model

Bingham rheological model is selected to represent the rheological characteristics, and the formula is as followed:

$$\tau = \tau_B + \mu\dot{\gamma} \qquad \tau > \tau_B \tag{1}$$

where, τ_B is the Bingham stress, and μ is the viscous parameter, and $\dot{\gamma}$ is the shear rate.

Results and conclusions

The Bingham model can be employed to represent the rheological characteristics of mud in most muddy ports of China. Fig. 1 is the relation of shear stresses and shear rates with different densities of mud, showing that the shear stress increases with the shear rate. And in range of high shear stress rates, namely larger than $10s^{-1}$, the Bingham mode is properly satisfied for the data.

The density of mud is the main factor affecting the Bingham stress. Fig. 2 shows the Bingham stresses of different densities of mud sample collected from different ports. The curves of Bingham stresses are not overlapping well, meaning that the differences of rheological characteristics are large for mud from different ports. The differences of particle size and the content of clay are the main reasons.

The effect of temperature on the rheological characteristics is not too significant, as illustrated in Fig. 3, while it is a little different in the range of high shear rates with different temperature.

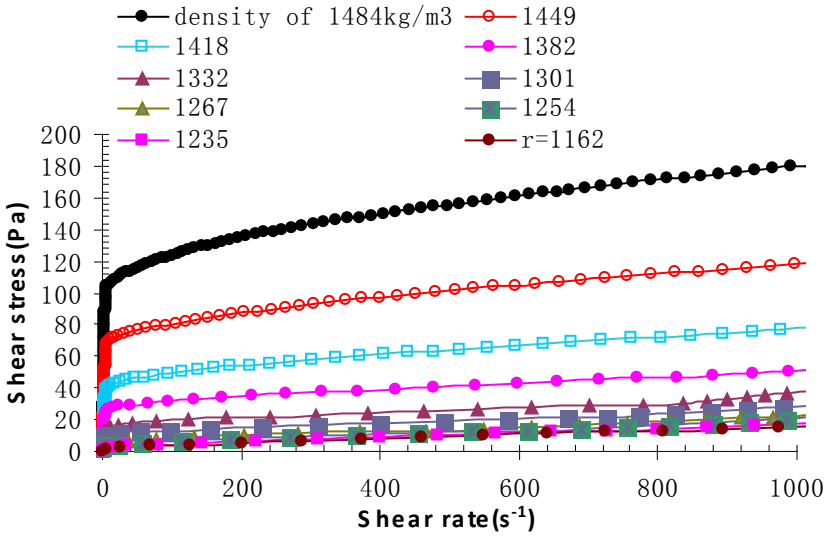

Fig. 1. Relations of shear stresses and shear rates for different densities of mud sample.

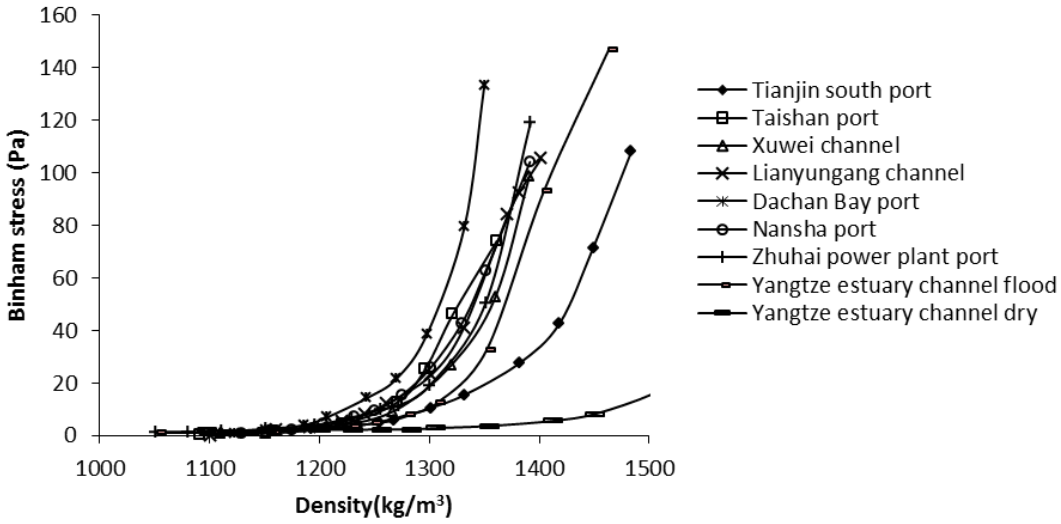

Fig. 2. Bingham stresses of different densities of mud sample collected from different ports.

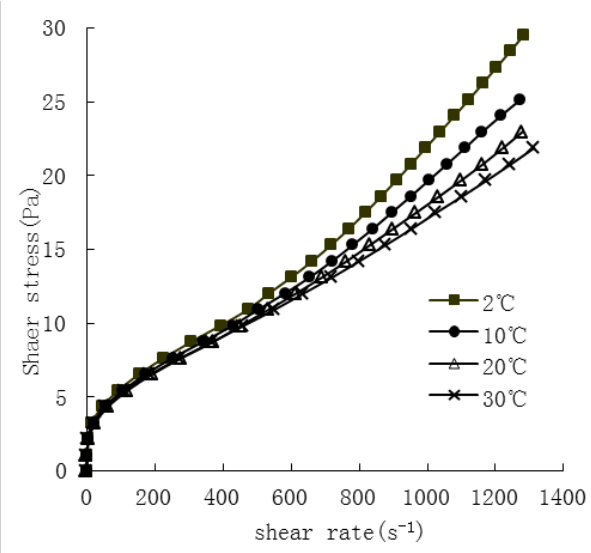

Fig. 3. Effect of temperature on the rheological characteristics of mud with density of 1200kg/m³.

References

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