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Dual Scattered-Light Sludge-Density Meter†

1. Introduction

The efficiency of sludge treatment and water treatment in sewage plants depends heavily on optimal chemical dosing ratios and stable operation, conditions which cannot be achieved without the accurate and reliable monitoring and control of the sludge density. Thus, highly reliable sludge-density meters will become increasingly important in the future.

Measuring instruments of various types have already been adopted as sludge-density meters, including the ultrasonic wave type, the near-infrared light type, and the microwave type. Each has its own merits and demerits. The most variable factors are the effects of the sludge color, bubbles, and adherent sludge on measurement performance. Other points of difference include maintainability, price, restrictions on applicable density ranges, and the ability to produce output in real-time (continuously). Overall, however, the state of the technology is poor: most sludge-density meters in use fail to satisfy users and are riddled with unsolved problems.

Fortunately, JFE Advantech has recently developed the SD-40, a dual scattered-light sludge-density meter without the usual flaws of other models. With help from the properties of near-infrared light, the SD-40 produces stable measurements even when sludge bubbles, adheres to the device, and varies in color. The SD-40 measures sludge of low to high densities continuously, in real time.

2. SD-40 Type Dual Scattered-Light Sludge-Density Meter

2.1 Product Outline

The SD-40 type dual scattered-light sludge-density meter is configured with multiple dual-wavelength light sources in a detecting module. These light sources allow the device to automatically correct the effects of sludge color based on correlation differences of the light-receiving characteristics of each wavelength. This function enables the device to measure with high accuracy even when the variations in the distribution of sludge volumes (an inevitable condition when the sludge comes in from different places) lead to subtle variations in the darker sludge colors (a common condition in sludge treatment facilities). The SD-40 type dual scattered-light sludge-density meter can even measure dark sludge, such as digested sludge, with stable output and good accuracy (conventional near-infrared light devices with single light sources normally are incapable of this measurement). The SD-40 is Japan's first near-infrared light type sludge-density meter endowed with this function and performance capability. Better still, an improvement in the detecting mechanism prevents the severe adhesion of concentrated raw sludge from impacting the output of the SD-40 (**Photo 1**).

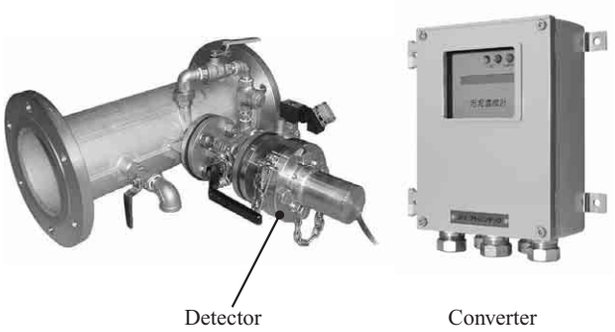

Photo 1 Detector converter

2.2 Principle of Measurement

The sludge to be measured (sludge) is directly irradiated with two kinds of near-infrared rays (A and B) with different wavelengths, emitted from optical fibers at the leading end of the detecting part. The scattered light of the near-infrared rays reflected from the sludge is received by an optical fiber and then converted into electric signals. The intensity of the scattered light reflected from the sludge correlates with the sludge density and sludge color. Each intensity of scattered light reflected from the sludge changes according to respective wavelengths in accordance with the darkness versus the lightness of the sludge. The sludge color effect is automatically corrected based on the difference in the correlation characteristics, thereby reducing the impacts of changes in sludge color on the output of the sludge-density meter (**Figs. 1**, **2**).

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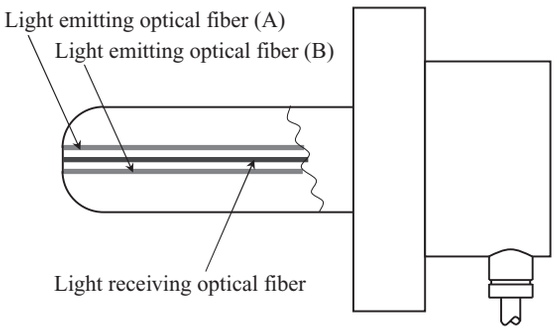

Fig. 1 Schematic drawing of detecting part

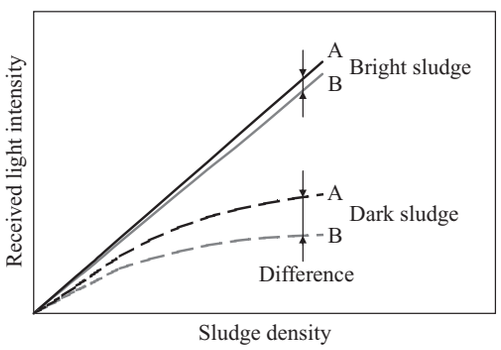

Fig. 2 Correlation between sludge density and light intensity

3. Performance of Product

3.1 Performance Related to Changes in Sludge Color

The densities of three types of sludge of different colors (properties) were gradually adjusted in steps by adding clean water. The actual densities were determined at each stage by manual analysis, and the measured densities were determined by offline analysis using a dual scattered-light type (the new dual light type) and single scattered-light type (the conventional single light type). **Figure 3** compares the performance of the two measurement devices.

In the case of a moderately bright sludge, both measurement devices showed good linearity and output measured densities that agreed well with the densities analyzed manually. The moderately bright sludge used in the experiment is approximately similar to general raw sludge, excess sludge, return sludge, and thickened sludge.

Once a thickened sludge putrefies, it darkens considerably. This type of thickened sludge usually corresponds to the 'dark sludge' classified separately from digested sludge in sludge treatment facilities and the like. The dual scattered-light type had good linearity in sludge of high-to low-density, and the densities measured with this device were almost equivalent to the densities analyzed manually. On the other hand, the single scattered-light type without correction had low linearity. With sludge densities of 0.5% or more, it becomes necessary to change the calibration curve and correction factors to prevent the measurement errors from increasing.

In the case of digested sludge, a considerably dark type, the output of the single scattered-light type almost reached saturation when the sludge density exceeded 0.4%. The single scattered-light type cannot be used as a measuring instrument in this region. The dual scattered-light type had good linearity and its output was almost equivalent to the density value analyzed manually. No effect of sludge color was observed.

3.2 Performance Related to Sludge Adhesion

Photo 2 shows the condition of sludge adhering to the detecting part when gravity-thickened sludge was

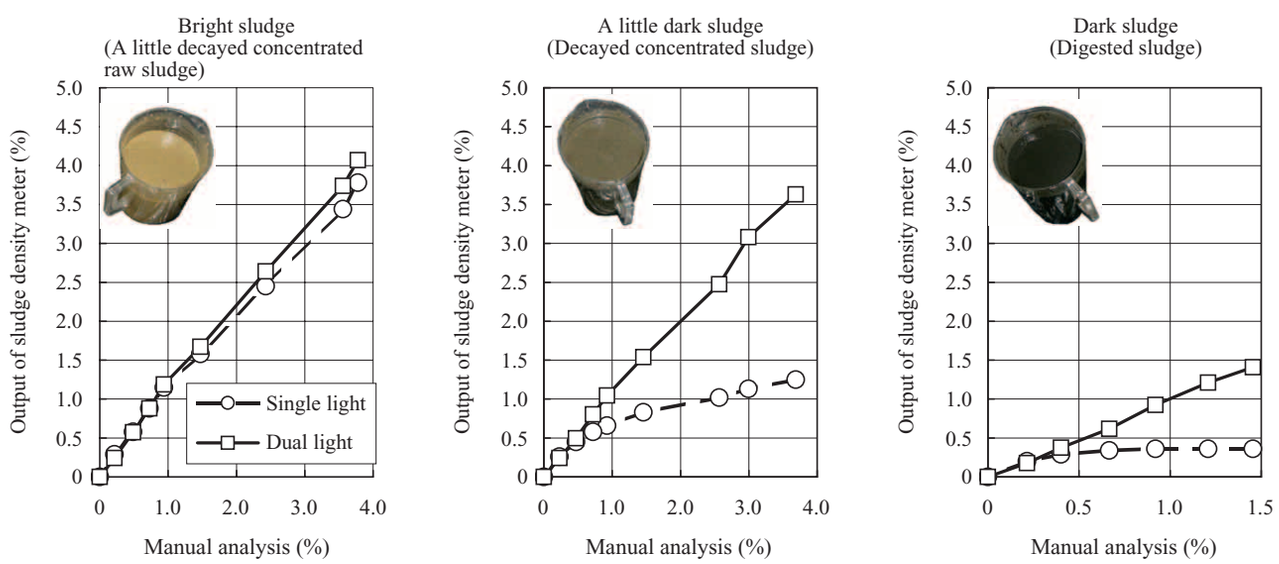

Fig. 3 Performance comparison of sludge density meter

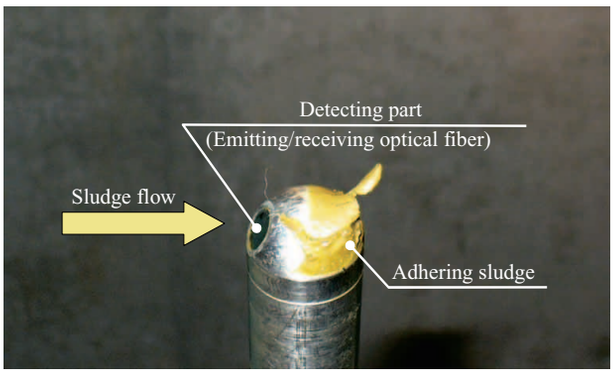

Photo 2 Detecting part adhered by sludge

measured by the SD-40 type dual scattered-light sludge-density meter without the cleaning operation by flushing water. Only a small amount of sludge adheres to the surface of the detecting part against which the sludge collides, when the detecting part is disposed in the sludge flow direction. The self-cleaning effect is thereby enhanced and minimal sludge adheres. The combined use of automatic cleaning by flushing water prevents further increases of sludge adherence and ensures freedom from maintenance for long periods of use.

4. Concluding Remarks

The SD-40 type dual scattered-light sludge-density meter is capable of continuous measurement of dark sludge, a type un-measurable by the conventional single scattered-light device, with high stability and accuracy. The SD-40 type is a high-performance sludge-density meter that frees operators from maintenance over periods of extended use even with sludge that tends to strongly adhere. In view of the continuous measurement capability, the high resistance against the effects of bubbles, and the easy maintenance, the SD-40 type can be described as sludge-density meter with practically no flaws.

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