Separation Efficiency of Nagar Parker China Clay Using Two Inch Hydrocyclone

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ABSTRACT

Performance efficiency of two inch hydrocyclone has been investigated, using the Nagar Parker china clay. Raw china clay was initially washed with tap water and -75 µm size fraction was separated through wet sieving. Washed china clay of -75 µm was used as feed sample in hydrocyclone tests. Solids concentration in slurry was kept as 2.5%. 45 tests were conducted with different combinations of pressure, vortex finder and spigot. Three sizes of spigot viz. 3.2, 2.2 and 1.5mm and three sizes of vortex finder viz. 7.00, 5.5 and 3.00mm were used. Hydrocyclone rig was operated at five different pressures viz. 20, 30, 40, 50 and 60 psi in conjunction with various combinations of vortex finder and spigot. Laser light scattering technique was used for particle size analysis of O/F (Overflow) and U/F (Underflow) products. Separation efficiency of the hydrocyclone, for various combinations of Vortex Finder, Spigot and operating pressure, was determined for two size fractions, i.e. less than ten micron and less than twenty micron, present in O/F and U/F products. From the results it was concluded that the best separation efficiency of 2 inch hydrocyclone is achieved by using the vortex finder of 7.0mm size and spigot of 1.5mm size. It was also concluded that the separation efficiency of the hydrocyclone decreases by increasing the pressure.

Key Words: **Separation Efficiency, Hydrocyclone, Nagar Parker Kaolin.**

1. INTRODUCTION

China clay is mainly composed of kaolin mineral having the molecular formula of $Al_2O_3.2SiO_2.2H_2O$, with 39.54% alumina (Al_2O_3), 46.51% silica (SiO_2) and 13.95% water (H_2O). Raw china clay contains many impurities like, feldspar, mica, quartz, oxides of iron and titanium, etc. Courser impurities can be removed by washing but Fe_2O_3, TiO_2 still remain in the washed china clay [1]. Kaolin particles are platy in shape and their size ranges from 0.1-100µm. Pure china clay is white in colour, its melting point is 1785°C and it disperses in water. It is widely used in paper and paint industry due to its excelent physical properties [2]. Industrial applications of china clay are enormous. It is used in sanitary ware, table ware, paper, plastic, cosmetics, fertilizers, pharmaceuticals and for making [3]. Pakistan is importing purified china clay from many countries for its local industry and it costs about Rs. 150/- million per year.

1.1. Nagar Parker China Clay

China clay deposits of primary origin are occurring in pockets, with varying thickness, near the surface at Nagar Parker, Sindh. Total reserves of the deposits are estimated around 4 million tons [4]. There are number of small scale

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washing plants in the area to separate fine particles through settling tanks. After washing it is filtered, air dried and sold in the local market. There is no proper processing plant for the purification of Nagar Parker china clay, that is why, many local industries import good quality kaolin from other countries for producing quality products. Average chemical composition of Nagar Parker china clay is: SiO_2= 46.0%, Al_2O_3=35.75%, TiO_2=0.86%, Fe_2O_3=0.85%, CaO=1.31%, MgO=0.34%, Na_2O=0.15%, K_2O=0.21% and Loss of ignition=14.23% [4].

Objectives of this study are two folds: First, the washing of china clay to separate the grit and second, size classification through hydrocyclone.

2. MATERIAL SAND METHOD

Raw kaolin samples, weighing 250 kg, were obtained from various locations of Nagar Parker area which were mixed properly to homogenize and then stored in plastic bags. Homogenized sample of kaolin was washed in the laboratory to prepare the feed sample for hydrocyclone tests, using the following procedure:

- Soaking of raw china clay in filtered water for 24 hours.
- Wet sieving using 75μm size sieve.
- Material obtained from wet sieving was dried and stored in plastic bags for later use in hydrocyclone tests.
- +75 μm size fraction was crushed and soaked in water for another 24 hours.
- Wet sieving using 75μm size sieve. Material obtained from wet sieving was dried and stored in plastic bags for later use in hydrocyclone tests.
- After second time washing, +75μm size fraction was discarded.
- Slurry containing -75μm size fraction, with solids concentration of 2.5%, was prepared in RO water.
- 0.3% of sodium-hexa- meta-phosphate was mixed to disperse the slurry and then it was conditioned for 15 minutes at 700 rpm.

The prepared slurry, of -75μm size fraction, was transferred to the tank of hydrocyclone test rig (Model: Mozely C700). Fig. 1 shows the test rig which was used to separate the fine size of kaolin from slurry. Slurry was injected in the cyclone with pressure. Coarser particles in the slurry move downwards and discharge through the spigot, while the finer particles move upward and discharge through the vortex finder. Major volume of water in the slurry discharges through the vortex finder, whereas, small quantity of water discharges through the spigot. Hydrocyclone was operated with various combinations of spigot (3.2, 2.2 and 1.5mm), vortex finder (7.00, 5.5 and 3.00mm) and pressure (20, 30, 40, 50 and 60 psi.). 45 hydrocyclone tests were conducted and O/F and U/F products were obtained from vortex finder and spigot respectively. After air drying, O/F and U/F products were weighed and stored in plastic bags. All O/F and U/F products were conditioned for few minutes in the presence of dispersant. After conditioning particle size analysis was conducted using particle size analyzer (LA 300) [5].

3. RESULTS AND DISCUSSION

From the particle size distribution results, three particle sizes of less than one micron, less than ten micron and less than 20 micron, present in O/F and U/F products, have been evaluated based on the total weight of the size fractions in feed sample. Separation efficiency of 2 inch hydrocyclone, for two sizes viz. less than ten micron and less than twenty micron, has been evaluated by dividing column 6 with column 9 and column 7 with column 10 respectively. These efficiency results are shown in columns 11 and 12 of Table 2. Figs. 2-4 show the graphical presentation for various sizes of vortex finder. In these figures separation efficiencies are plotted against various combinations of spigot and pressure. Highest efficiencies are obtained by using the vortex finder of 7.0mm size and spigot of 1.5mm size as shown in Fig. 2. Lowest efficiencies are obtained by using the vortex finder of 3.0mm size and spigot of 1.5mm as shown in Fig. 3. Intermediate efficiencies are obtained by using the vortex finder of 5.5mm size and spigot of 2.2mm size as shown in Fig. 4. Comparision of separation efficiencies are shown in Fig. 5, where separation efficiencies are plotted against the operating pressure for three combinations of vortex finder and spigot. It is evident from the Figure 5 that the separation efficiency of the hydrocyclone reduces by decreasing the size of VF. and increasing the pressure. It is also clear that the most efficient combination is VF/Spigot=7.0/1.5.

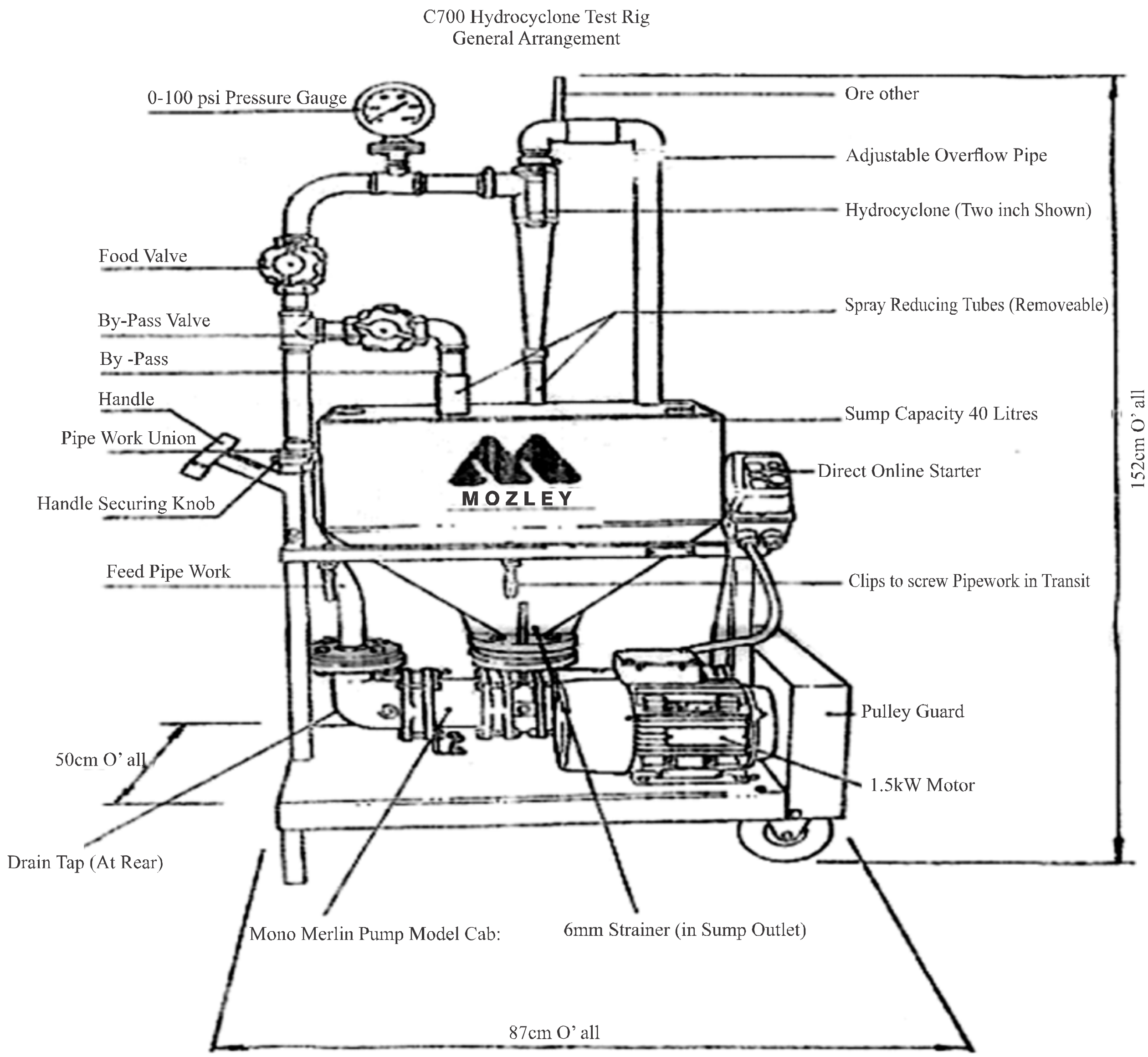

FIG. 1. HYDROCYCLONE TEST ASSEMBLY (MOZELY C700)

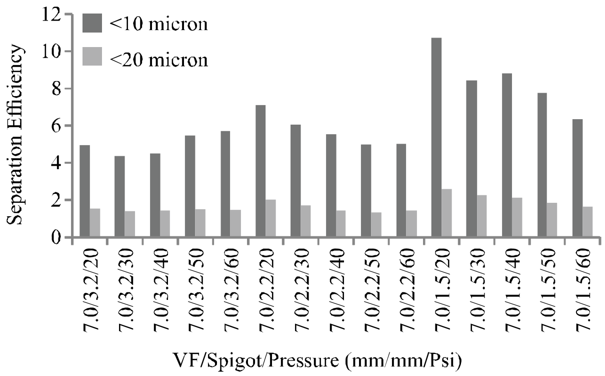

FIG. 2. SEPARATION EFFICIENCY FOR VF=7.0mm WITH THE COMBINATION OF VARIOUS SPIGOT SIZES AND PRESSURES [5]

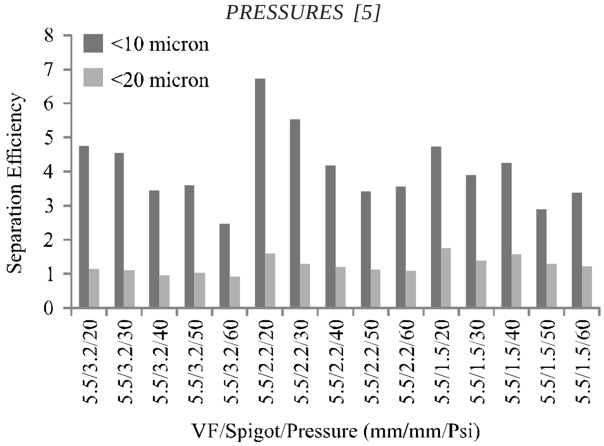

FIG. 3. SEPARATION EFFICIENCY FOR VF=5.5mm WITH THE COMBINATION OF VARIOUS SPIGOT SIZES AND PRESSURES [5]

4. CONCLUSIONS

Based on the results and discussions, presented above, the following conclusions can be made:

(i) Best separation efficiency of two inch hydrocyclone, for Nagar Parker kaolin, is achieved by using the vortex finder of 7.0mm size and spigot of 1.5mm size.

(ii) Separation efficiency of the hydrocyclone decreases with the size of vortex finder and by increasing the pressure.

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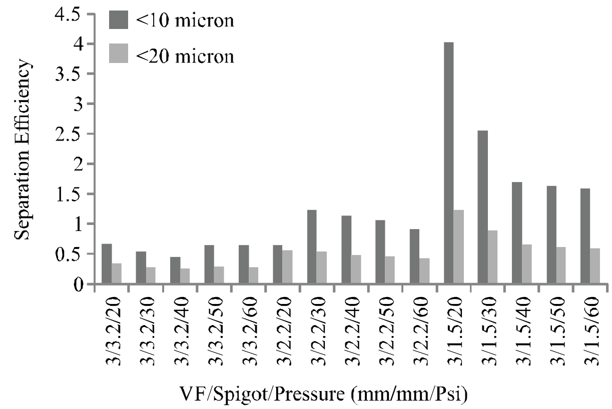

FIG. 4. SEPARATION EFFICIENCY FOR VF=3.0mm WITH THE COMBINATION OF VARIOUS SPIGOT SIZES AND PRESSURES [5]

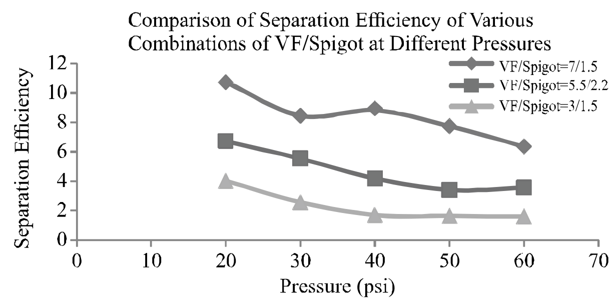

FIG. 5. COMPARISON OF EFFICIENCIES OBTAINED AT VARIOUS COMBINATIONS OF VF AND SPIGOT [5]

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