THE UNIVERSITY OF JORDAN

FACULTY OF ENGINEERING AND TECHNOLOGY

SCHOOL OF ENGINEERING

DEPT.OF CHEMICAL ENGINEERING

Chemical Engineering laboratory 2 (0915461)

Section no. (1)

Experiment Number (8)

Ball mill

Short report

Done by:

Instructor's Name: Prof. Dr. Motasem Saidan & Eng. Arwa Sandouqa

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ABSTRACT

Ball milling is a mechanical technique that used to grind powders into fine parts which increases the surface area per unit volume and thus increases the reaction rate, also used to obtain the size distribution of the final mixture by sieving.

The ball mill contains a hollow cylindrical shell that rotates about its axis. This cylinder is filled with balls made of stainless steel and the material to be grinded (oil shale).

the principle of this technique, when the shell rotates, the balls are lifted up on the rising side of the shell and then they drop down on to the feed, from near the top of the shell. In doing so, the solid particles in between the balls and ground are reduced in size by impact

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RESULTS

Table(1):data

	Sample #1	Sample #2	Sample #3
Feed particle size (μm)	1400-850	1400-850	1400-850
Weight of sample (g)	100	100	100
Time(min)	5	10	15
Rotational speed	250	250	250
Power consumption(w)	10	10	10

Table(2):sample 1

Sieves size	Average screen opening	Mass retained (g)	Mass retained %	Accumulative mass retained %	Accumulative mass passing %
500	500	82.801	82.7993	82.7993	100
250	375	7.7	7.6998	90.4991	17.2007
125	187.5	2.802	2.8019	93.3011	9.5008
90	107.5	1.419	1.4190	94.7201	6.6989
63	76.5	1.58	1.5800	96.3001	5.2799
<63	63	3.7	3.6999	100.0000	3.6999
total		100.002	100.0000		

Table 3: sample 2

Sieves size	Average screen opening	Mass retained (g)	Mass retained %	Accumulative mass retained %	Accumulative mass passing %
500	500	72.137	72.1363	72.1363	100
250	375	10.463	10.4629	82.5992	27.8637
125	187.5	5.859	5.8589	88.4581	17.4008
90	107.5	2.89	2.8900	91.3481	11.5419
63	76.5	3.246	3.2460	94.5941	8.6519
<63	63	5.406	5.4059	100.0001	5.4059
total		100.001	100.0000		

Table(4): sample3

Sieves size	Average screen opening	Mass retained (g)	Mass retained %	Accumulative mass retained %	Accumulative mass passing %
500	500	57.836	57.8366	57.8366	100
250	375	14.075	14.0751	71.9117	42.1634
125	187.5	7.034	7.0341	78.9458	28.0883
90	107.5	4.514	4.5140	83.4598	21.0542
63	76.5	3.95	3.9500	87.4098	16.5402
<63	63	12.59	12.5901	100.3600	12.5902
total		99.999	100.0000		

Table (5): power and work index

	Weight of sample(g)	Weight of sample(ton)	Time (hr)	Feed rate (ton/hr)	Power required for grinding (kw)	Feed particle size mm	Particle size of product d80 mm	Bonds work index
Sample 1	100.0000	0.0001	0.0833	0.0013	0.01	1.125	0.47	47.19
Sample 2	100.0000	0.0001	0.1667	0.0006	0.01	1.125	0.46	99.2
Sample 3	100.0000	0.0001	0.2500	0.0004	0.01	1.125	0.45	144.34

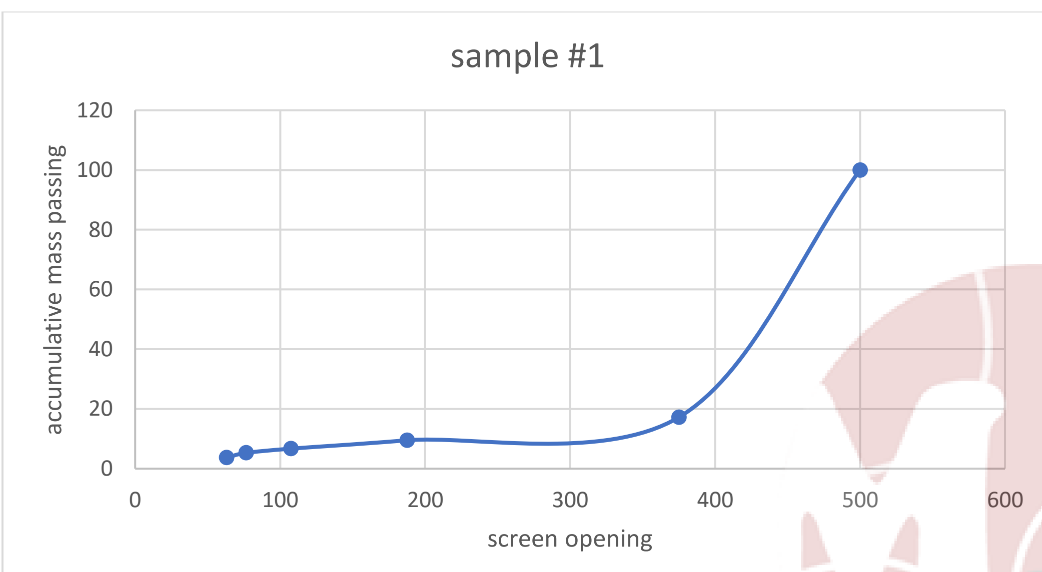

Figure (1):sample 1 accumulative mass passing vs screen opening

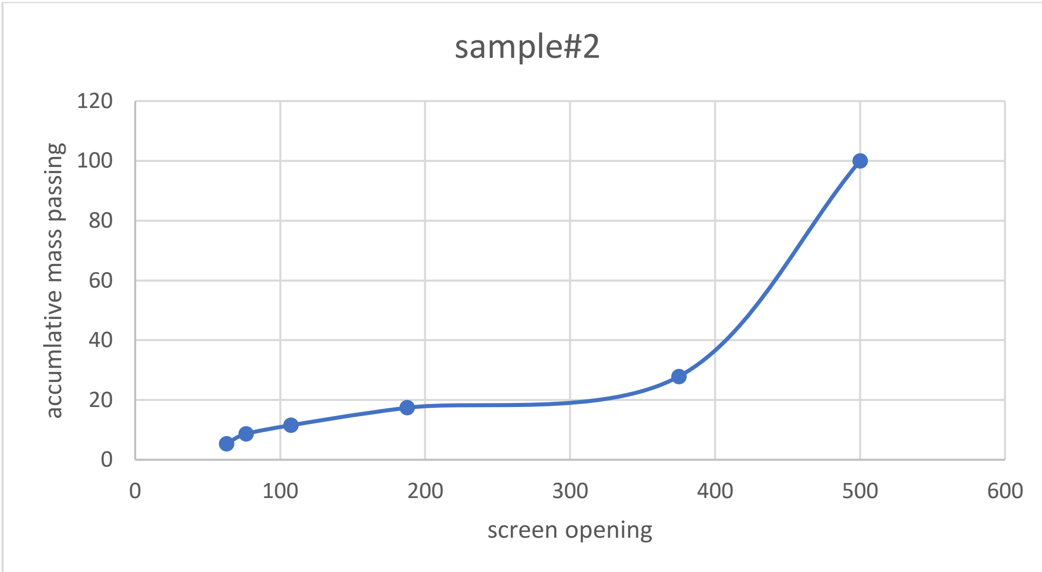

Figure (2):sample 2 accumulative mass passing vs screen opening

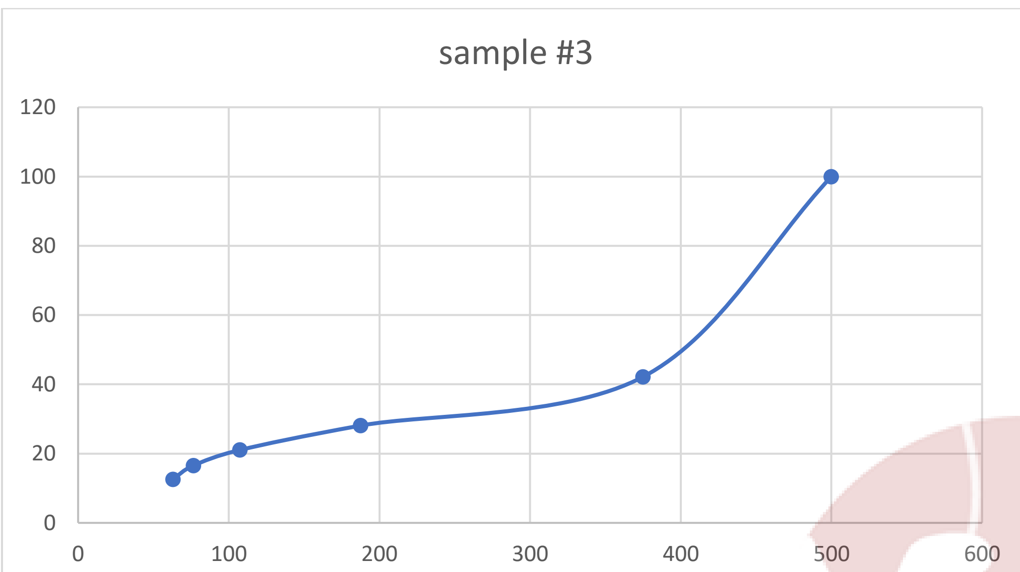

Figure (3):sample 3 accumulative mass passing vs screen opening

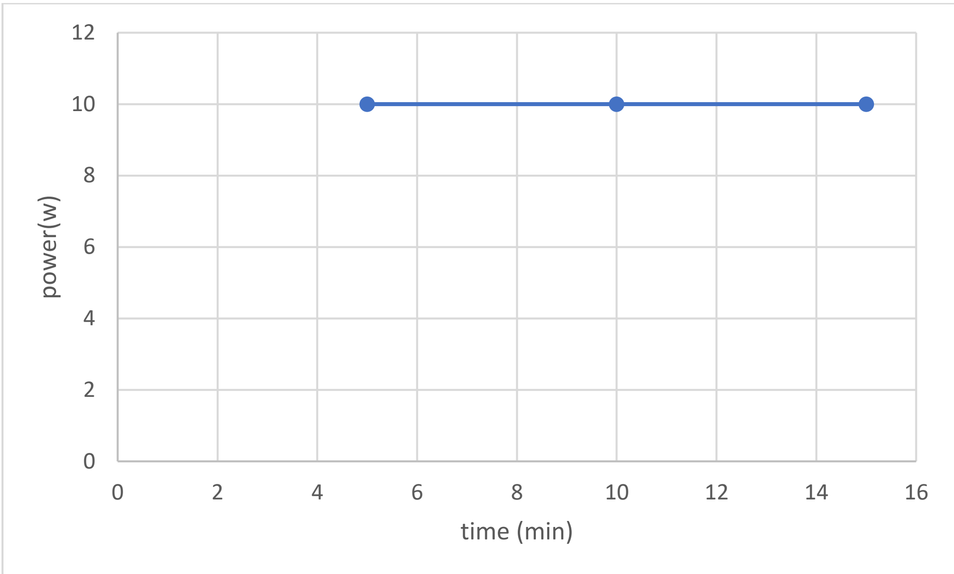

Figure (4): power vs time

DISCUSSION

The ball mill's primary function is to reduce particle size as much as needed to complete a specific process. In this experiment, our goal was to investigate the effect of power in the milling process while keeping all other parameters constant. As a result of the data obtained, we can conclude that as the power consumption of the ball mill increases, more particles with smaller particle sizes (less than 90 micrometers) will be produced with the time and speed of rotation remaining constant.

On the other hand, we may predict that the efficiency of particle reduction will increase if we increased the speed of the ball mill as more torque will probably break the tension of the particles in contrast, an increment in time of mixing doesn't mean that the process will be more efficient as we may have a certain agglomeration and mixing while crushing the material, which in advance will lead to particle increment rather than particle decrement. We can also observe that the d80 property (which is the diameter at which 80% of the feed passes through) is almost identical for both samples, that since they are not having a large difference in the particle size, this reason is also responsible for the reason why the power consumption is not having a large difference, As we increase the power required to crush, the working index will rise as it is directly proportional to the power applied in bond law. Additionally, the power required to crush the particle size will be inversely proportional to the particle diameter, implying that we will require more power to crush small particle diameters and vice versa. This is due to the surface area tension phenomenon, which states that as particle size decreases, the surface area volume ratio rises. As a result, more power is required, which is what we discovered in this experiment. The only critical error that one may commit in this experiment is not observing the right power consumption as the device automatically erase the data from the panel as the time reaches zero, in that way we cannot predict what was the power consumed by the mill to crush the material, also an error could emerge from accidental sample wastage by spilling the material, and this can lead to serious problems most probably in sieving.

CONCLUSIONS

- The accumulative weight percent of the product decrease when screen opening increase
- The power is constant with time
- The crushing process effects by (ball size and volume share , speed of cylinder , type of materiel, time)
- accumulative mass passing increases as screen opening increase

REFERENCES

Appendix

Sample of calculation

Sample 1:

Feed particle size = L1 = 1152 μm

Weight of sample = 100 g

Wieght of sample (ton) = 100/100000 = 0.001 ton

Time = 5 min=0.0833h

Rotation speed = 250 rpm

Power = 0.01 KW

feed rate (ton / hr) = weight (ton) / t (h)

= 0.001 / 0.0833 = 0.0013

- from the Accumulative weight percent VS screen opening graph:

  $d_{80} = 0.47mm$

Bonds law:

$$\frac{p}{m} = 0.3162\ W_i \left(\frac{1}{\sqrt{L_2}} - \frac{1}{\sqrt{L_1}} \right)$$

$$\frac{0.01}{0.0013} = 0.3162\ W_i \left(\frac{1}{\sqrt{0.47}} - \frac{1}{\sqrt{1.152}} \right)$$

bond's work index (kw.hr/ton) = 47.19