DESIGN AND ANALYSIS OF HIGH EFFEICIENCY MAGNETIC SEPARATOR

Walaa Saadeh, Jamil Haddad & Ryo Amano

INTRODUCTION

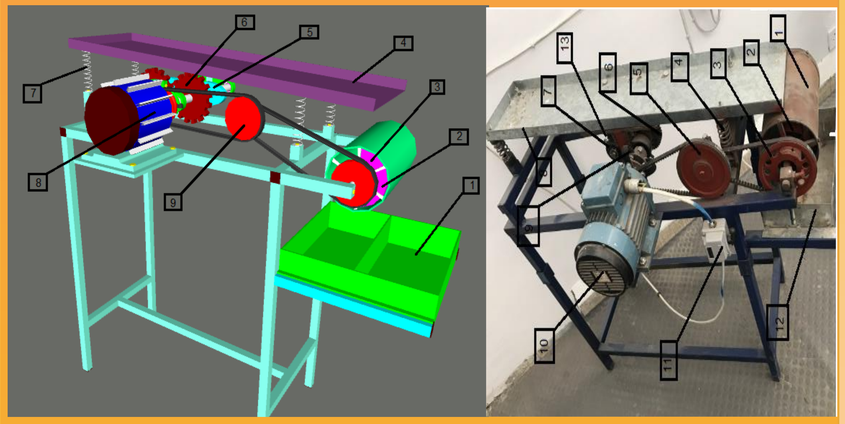
- The magnetic separation is a process of separating magnetic materials by using magnets, the magnetic separation process detaches nonmagnetic materials with those who are magnetic this process done by a device called **Magnetic Separator**.
- The main objectives of Separating process are to separate ferrous materials from those who are not, and to separate the steel materials (that occurs because of the friction between steel balls in vertical vibrating milling machine) from the ore.

OBJECTIVES

Design an efficient model for magnetic separation

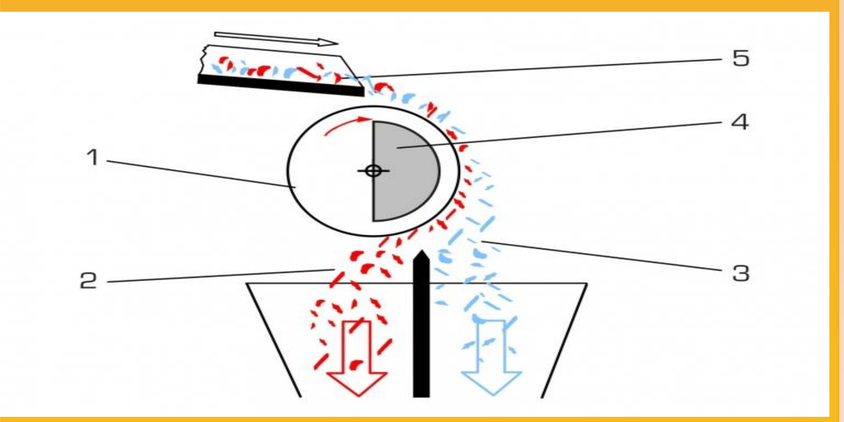
- To study relation between centrifugal force and other parameters such as magnetic force effect, roll speed, and particle size.
- To study the effect of different parameters (Roll speed, magnetic force, and mass of particle) on separation efficiency.
- To find the optimum conditions for magnetic separation process to enhance the separation efficiency.

MAGNETIC SEPARATOR MODEL



1. Splitter tank.
2. Magnet.
3. Drum(Roll).
4. Blade.
5. Rotating masses.
6. Gears.
7. Springs.
8. Electrical Motor.
9. Pulleys.

MAGNEETIC SEPARATION PRINCIPLE



1. Drum. 2. Ferrous Materials. 3. Non-Magnetic Materials. 4. Magnet. 5. Blade (Feeding regulator).

THEORY

- The equation to find magnetic force is :
  $f_m = \mathrm{XmH}\nabla\mathrm{B}$ …. (1)
- The equation to find centrifugal force is:
  $f_c = m\omega^2 R$ … (2)

Where,

X: mass magnetic susceptibility (=0.276 m^3/kg) for steel.

m: mass of the particle (kg).

H: magnetic field strength (A/m).

∇B: magnetic field gradient (T/m).

ω: angular velocity of the roll $= \frac{2\pi N}{60}$ (rad/sec).

R: radius of the roll (drum) (m).

METHODOLOGY

I) Model Design:

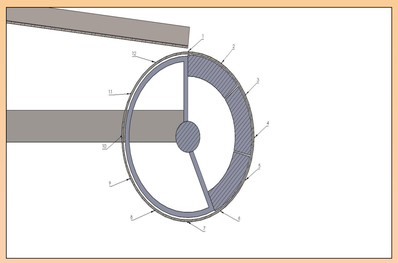
- The magnetic separator device is designed and simulated in Magnetostatic analysis type by using SolidWorks software.
- The drum is with 8cm in radius and length of 360mm, has a three magnets coupled with each other with dimensions: 340 mm of length, 40 mm width and the thickness is 20 mm to give the required magnetic force.
- Two different sizes (1 and 0.7)mm in diameter of silica sand mixed with steel ore were fed to magnetic separator.
- After feeding the two different sizes of particles to the roll(drum) with magnet, the force density of magnet will attract the fed particles.

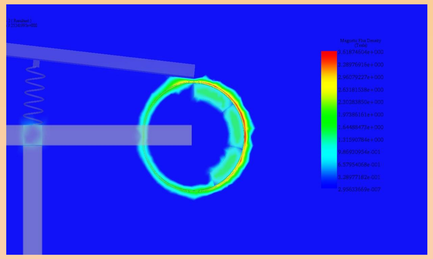
II) SolidWorks Simulation

- The SolidWorks software will give the magnetic flux density.
- The force density (N/m^3) of magnet is constant, but the magnetic force (N) to attract the steel particles will vary by radius of the steel particles.
- The results of the Solidworks software were compared with the theoretical results.

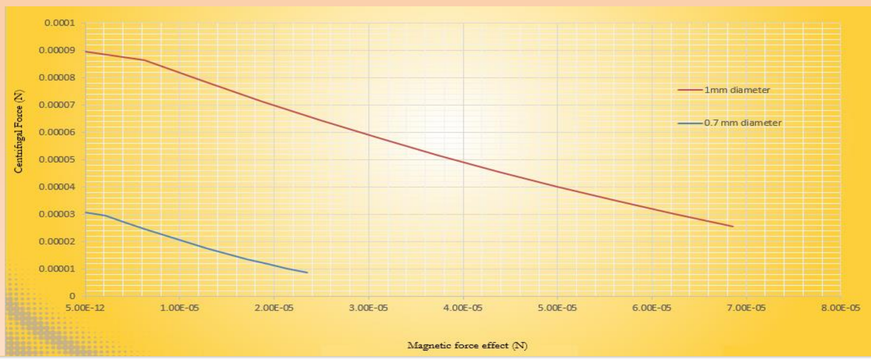
RESULTS

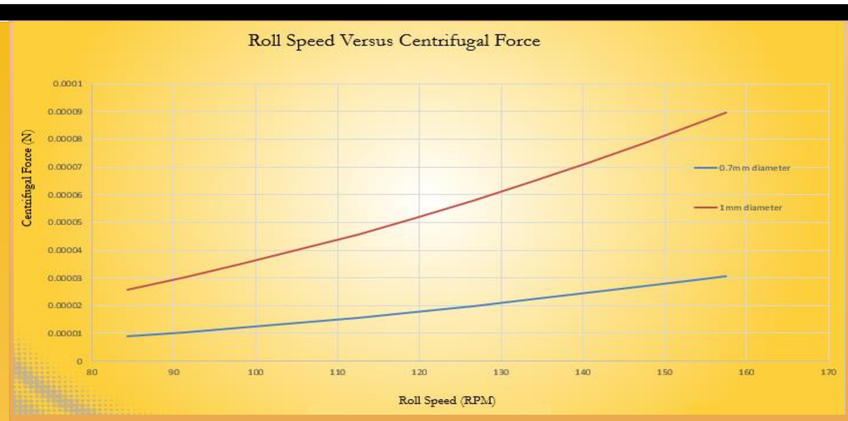
- **Particle Position:**



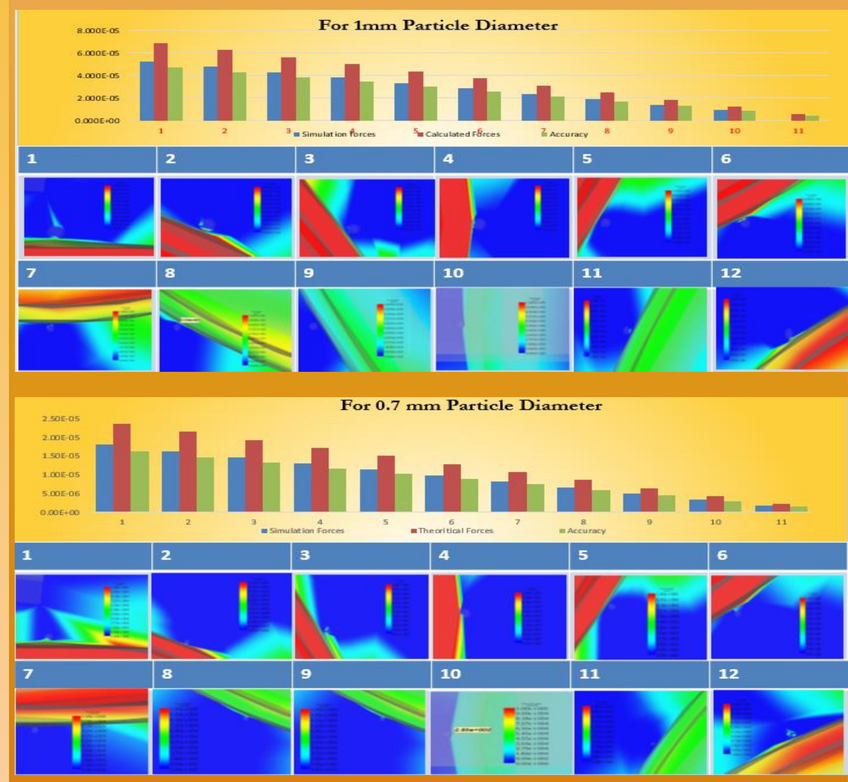


- **Centrifugal force effect on different size particule diameter:**





- **Comparison between theoretical and simulated forces:**



CONCLUSIONS

- The centrifugal force are the most variable important parameter affects on separating efficiency.
- The optimum separating conditions to reach higher rate of separating process were 174 degree of blade angle with magnetic force 68.6 μN and roll speed from (84 to 105 RPM).
- It is not recommended to use this device at speeds above 112 RPM because the separation efficiency will drop.

CONTACT INFORMATION

Prof. Ryo Amano: amano@uwm.edu
Center Director
Industrial Assessment Center
University of Wisconsin-Milwaukee

Walaa Saadeh: whsaadeh@uwm.edu
Research Assistant
Industrial Assessment Center
University of Wisconsin-Milwaukee

Industrial Assessment Center
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