Final Year Project Showcase Batch 2018
Year 2022

Department: Mechanical Engineering Programme: Mechanical Engineering		
1	**Project Idea**	Design and Development of Compact Equipment for the Grading of Material Composed of Dry Micro Size Particles
2	**Process**	An extensive review of the existing research and available options was carried out by going through the literature and commercially available equipment. The equipment was designed using analytical calculations and computer-aided design tools. After the procurement of the material and development of equioment, a series of hit and trial testing was done for tuning the equipment for optiminum parameters. The equipment is adjusted to segregate calcined clay particulate into two grades. Material smaller than 149 microns mesh size can be collected in one container and above go into a second one. The wastage is as low as 2.5% of the total materials. Extremely light particulate may flow out with the air. These can be controlled by placing dust collector at the discharge side of the air.
3	**Outcome**	Calcined clay particulate or any other dry material can be segregated into two grades using air cyclone. Except the blower, no moving parts in the system, the device requires less maintenance and operating cost. The fabricated device is easily detachable and easy to relocate at different locations. On operating on full RPM capacity with a flowrate of 7.5 m^3/min, the device gives around 5 % losses and the desired fine sample collected which is <149 microns is ~6% of the feed sample. On decreasing blower RPM periodically loss percentage gradually increase, simultaneously decreasing the separation efficiency. The fabricated device is designed to separate the treated sample, i.e the feeding sample, must be dehumidified and contains no moisture content. Else, the material would contribute in the degradation of the equipment and also it will affect the working efficiency of the cyclone separator. The prototype has the potential to be replicated on the larger scale, and could be commercialized and implemented in any relevant industry. The Equipment will bridge the gap in present and the current market by replacing the Sifters.
4	**Evidence (Theoretical Basis)**	Solid-Solid microparticle separation from a carrying flow is a widely used industrial technique, various types of equipment are available in the market which facilitates the separation of solid-solid mixtures. This project aims to develop compact equipment that can be placed and used in a lab to perform solid-solid microparticle separation. Also, it has the potential to be replicated on a commercial scale to fulfill the need of relevant industries. After going through a literature review involving different microparticle separation devices, it is found that Vibratory Sifters are used worldwide on a laboratory scale but it involves several

		drawbacks like, it is a non-continuous process of separation as well as it involves the use of sieves which gets clogged and needs to be cleaned regularly. On the other hand, a cyclone separator is a particle separation apparatus that uses centrifugal force to sort particles based on their size. They are better than the devices which involve sieves for the separation since they are simple, continuous, and economical to use. The design of the equipment consists of two cyclone separators (Inverse and Conventional in series). The inverse cyclone separates the particles according to the size while the conventional is used to separate the fine particles from the airflow. In order to perform the experimentation kaolin clay was used as the input feed, and the aim is to separate particles having size < 149 microns. Initially, our design involves a single conventional separator and a prototype was constructed using cardboard but it turned out to be a failure. After the series of trials, an inverse cyclone was added to our design to increase the separated amount of the sample, and then the third prototype was constructed. When the third prototype was tested, it was found that this design worked fine as per our desired results and it was concluded that our final design will be based on the third prototype. After fine refinements in the third prototype, 3D model of the final design was drafted on AutoCAD using the dimensions of the prototype. After the finalization of the design, fabrication of the equipment was done using Polyvinyl Chloride (PVC) as the main equipment material while wooden planks and Steel were used for the manufacturing of the frame. Finally, the equipment was tested in a controlled environment using Calcined Kaolin Clay and from the results, we concluded that this equipment is separating the fine particles from the clay sample at 97% accuracy of which ~75% fine particles are <74 microns and ~23% fine collected passes through 100 mesh size sieves (<149 microns).
5	**Impact on Sustainability of Urban Regions or SDG-11 "Sustainable Cities and Communities"**	The product is design to produce calcined clay to introduce LC3 eco-friendly cement in Pakistan. The cement has 25% lower carbon foot prints
6	**Competitive Advantage or Unique Selling Proposition** Samll Scale, Portable, Light weight, Low maintenance, Time Efficient, Low Cost	
a	**Attainment of any SDG** (e.g. How it is achieved and why it is necessary for the region)	Decent Work and Economic Growth Industry, Innovation and Infrastructure Responsible Consumption and roduction Climate Action
b	**Environmental Aspect** (e.g. carbon reduction, energy-efficient, etc.)	Helps to counter the dust in the ambient environment
c	**Cost Reduction of Existing Product**	**~50% compared to conventional ones**
d	**Process Improvement which Leads to Superior Product or Cost Reduction, Efficiency**	It could be fully automated through the installation of multiple sensors

	Improvement of the Whole Process	
e	**Expanding of Market share** (e.g. how it expand and what is the problem with the current market	This study aimed to design and develop a new type of microparticle separation equipment consisting of cyclone separators. The equipment will have a high collection efficiency with low-pressure drop. The design will include two cyclone separators connected in series. The first one will work as an Inverse cyclone separator whose function will be to separate the fine kaolin clay from the overall sample. The fine clay will travel to the second cyclone separator, through a gas flow, which will function as a conventional cyclone separator, separating the fine clay from the airflow. The grain size of Kaolin Clay used in concrete making should be at most 149 µm and the optimal size used is 88 µm. The proposed device will extract the fine Kaolin clay (<149 µm) from the Kaolin clay sample. The equipment should provide our desired sampled clay at a rate of at least 1000g per hour. The equipment will be economical as compared to the international market. Also, it will be fully automated since it will include programmable sensors that detect the particle size and automatically calculate the volumetric flow rate of the fluid, percentage composition, etc.
f	**Capture New Market**	Small scale industries or companies within the state
7	**Target Market**	Pharmaceutical industry, Cement industry, Food & Dairy industry, Paint industry, and Manufacturing Industry (Sand Casting)
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10	**Pictures**