Study and Analysis the Mechanical Designing Process of Factor Attributes Towards the Propose Dewatering Devices in Wastewater Industry

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***Abstract*—In every year, the volume of municipal sewage has been increased due to increasing of population in Malaysia. The operation of municipal treatment should be gone for the larger scales for operation and disposal. The operation, the pre-treatment plant, post treatment plant until the suspended solid can be disposed to landfill or do some burning process to gain the methane gas towards to renewable energy. It has to meet the requirement by Department of Environment (DOE), which is by removing at least 90% of water from the suspended solid, focusing on the municipal sewage treatment. The wastewater industries need to have another alternative solution to for the time reduction of the drying process from the existing dewatering instruments or may have the new concept of the devices, which can easily help to remove the water from the suspended solid. Based on the pilot study from the industry, the dewatering bag as their chosen for the dewatering instrument. It is because of its huge of benefit such as cost. By designing a new portable dewatering device that will supply hot air to support the dewatering bag, so it will not only depends on natural heating element (sun), as a vital problem that have to be settled. So this paper presents the pilot data finding by comparing two dewatering bag, one by using the propose Universal Compress Air Fit (UCAF) and another one without it in real application. . UCAF itself that supply hot air to the sludge can helps the sludge to dry 30% faster than usual.**

Keywords-dewatering devices; propose universal compress air fit (UCAF)

I. INTRODUCTION

Dewatering in its simplest definition is the removal of water. This procedure is used in many industries, but normally referred to construction and wastewater when water is distinguished from solids through a form of different pumping or filtering operations. Construction dewatering is often mention to as dewatering, unwatering, or water control. It involves pumping from wells or sumps to temporarily lower groundwater levels, to allow excavations to be form in dry and stable conditions below natural groundwater level. The production of a waste stream is a small in comparison to the overall process output; nevertheless, can still pose a number of significant problems. Firstly, the volume of waste in the process reduces the available volume to be used for the process. Direct disposal into the environment of especially oil wastes can be detrimental to the surroundings if a treatment is not applied as stated by Chen et al [1]. The post-treatment system applied to the waste product should depend along the specific treated product required.

The objectives of post-treatment can range from achieving a product that can be safely disposed, recycled into the refining process or requires an adequate water phase to be re-used in the process. Accordingly, the existing dewatering instruments that been use in the wastewater treatment industry such as Filter press machine, Decanter centrifuge machine, Dewatering bag and Belt filter press machine as depicted in Table 1. The purpose of all dewatering devices is still the same is to remove water from the suspended solid to form the sludge cake or dry sludge before disposing.

Based on the pilot study from the industry, the dewatering bag as their chosen for the dewatering instrument, compared to filter press machine and decanter centrifuge. It is because of the benefit of the dewatering bag that is most suitable to use in any condition of the wastewater. It also easy to install (plug and play) and will be dispose after being use. It also has an option for the size of dewatering bag depend on the volume sludge disposal. It has a limitation because depending only on the natural heating element (sun) which take longer time to get the dried sludge. The critical comparison, being discuss further in theoretical approach. Nowadays, the wastewater industries need to have another alternative solution for the time reduction in drying process or new concept of the devices that can easily remove the water from the suspended solid. Consequently, by designing

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a new portable dewatering device to support dewatering bag, it will cause more benefit that can overcome and help the main problem.

The comparison of data findings between the normal usage in industries and the proposed Universal Compress Air Fit (UCAF) become the main concerns in this paper.

TABLE I. TYPE OF DEWATERING DEVICE IN INDUSTRY

		
Filter press machine	Decanter centrifuge machine	Dewatering bag

II. LITERATURE REVIEW

A. Factor Attributes of Mechanical Dewatering

The volume of municipal sewage sludge has increased due to the intensification of water purification, and the cost of disposal of the sludge has increased due to more tight and high in term of law for the environment protection. Both of the factor which are the volumes that need to be treated and their moisture content are related to reducing the cost of sewage sludge are important to environment (e.g. disposal, transport, storage). The mechanical processes like gravitational settlers, centrifuges, belt filter press and filter press machine decanter (Table 1) are usually common used for removing the contamination from the sludge. The importance to study the sludge treatment management is agreed by Chen et al [1] and Mahmoud et al [2] which is the dewatering efficiencies obtained with wastewater sludge are generally low, 35% (solids on a wet basis) seems to be around the highest value that can be reached even when the sludge is conditioned before dewatering. Hence, in order to dispose the sludge cake to have the further action it has to do some sort of management of the sludge control operation that can call it as Sewage sludge management. According to Ozdemi and Yenigun [3] statement, the effect of this behavior sludge treatment and disposal always been around half of the total plan operating cost so that the wastewater treatment process may convert a water pollution control problem into a solid waste disposal problem, supported also by Weemaes and Verstraete [4].

According to Qi *et al.* [5] a strong reduction of sludge volume can be achieved by means of mechanical dewatering. Nevertheless, activated sludge is a poorly dewaterable matrix by Dursun *et al.* [6], being thus a power consuming operation of the wastewater management. Reliability and high efficiency of dewatering system must be considerable. A common issue for mechanical dewatering devices lies in the choice of the proper conditioning manners which is too much of chemical additives such as polymer flocculants by Boran *et al.* [7], are commonly used to control the inter-particle interactions in the sludge by Aziz *et al.* [8].

In order to make properly assess dewatering devices, an integrated approach is a fundamental concept of the opposite situation by Mamais *et al.* [9] and Uggetti *et al.* [10] that the global mass balance of solids (also considering the supernatant) and all process parameters should be accounted as some of the investigations. This research studied the optional of dewatering devices in industries, which help to know their factor attributes. Filter press machine, decanter centrifuge, and dewatering bag (Table 1) is being studied based one the pilot finding of industry favorable. The comparison among them, the gap analysis is being studied to find out the best use in industry.

Filter Press is the mechanical device, which is specially particularly used in solid or liquid separation using the principle of pressure driven, which is provided by a slurry pump is called as plate and frame filter press. Construction of the filter press is simple and variety of materials can be utilized. It has provided a large filtering area in the relatively small floor space. It is versatile, the capacity being variable according to the heaviness of the frames and the number employed. Other than that the surface area can be increased by employing chambers up to 60 according to Gordon et al [11]. The sturdy construction permits the use of the considerable pressure difference. About 2000 kPa can be normally used as stated by him [11]. Efficient washing of the cake is possible. Operation and the maintenance are also just straightforward because there are no moving components besides filter cloths are easily renewable. Besides the good one, the filter press also not among the favorable, this is due to expensiveness. The emptying time, the labor involved and the wear and tear of the cloth resulting in high cost where the filter press is used for the slurries containing less than 5% solids as claim by Aksenova *et al.* [12].

A decanter centrifuge separates solid materials from liquids in slurry and thud scats as significant role in wastewater treatment, chemical, oil and food processing industries according to Aksenova *et al.* [12]. The decanter centrifuge is versatile as easy different lengths of the cylindrical bowl section and the cone angle can be selected for different applications. Likewise, the arrangement can be pre-programmed with various design curves to predict the sludge type, while some competitive processes, such as a belt filter press, cannot change the belt type to operate for different sludge types. Its versatility allows the machine to

have various functions such as operating for thickening or dewatering by Qi *et al.* [5].

A gravity bag filter, also referred to as a dewatering bag, is a square or rectangular bag made of non-woven geotextile fabric that collects sand, silt, and fines. Xinchao *et al.* [13] said that, a secondary barrier, such as a rock filter bed or straw bale barrier, is placed beneath and beyond the edges of the bag to capture sediments that escape the bag. The bag will be filled when it stops filtering or passing water at a reasonable rate. If the bag is swelling quickly, reduce the volume to allow the bag to settle by Xinchao *et al.* [13]. In wastewater industry, there are many several types of dewatering devices that can be used depending on the budgetary cost of the company, including the service and maintenance. The space required for the dewatering device, the transportation also the effectiveness of the dewatering device itself. The purpose of all dewatering devices is still the same is to remove the water from the suspended solid to form the sludge cake or dry sludge to be disposed of further action. Most of dewatering devices need to add up with the chemical polymer as the aim is to mixed up the sludge to be solid and easy to trap the sludge into the filter, membrane or bag and the water will flow out from the devices to remain the sludge to be dry for a certain period. This device is the most favorable in industry compared to filter and decanter machine due to its functional and cost. The gap analysis as stated in Table 2.

TABLE II. GAP ANALYSIS OF DEWATERING BAG

Advantages	Disadvantages
• Once the soil filter is established, fairly efficient removal of sediments.	• Depending on the natural heating element for the dewatering bag to be dry.
• Easy to install and transport to site.	• Limitation to the sludge volume.
• Disposable, no cleaning required.	• Water cannot flow out if the polymer are placing too much inside it. It will require a proper ratio of the polymer to flow through the dewatering bag.
• Inexpensive Fabrics vary to meet engineering specifications for flow rates, strength, and permeability.	• Need a skillful worker to do the cutting process before the damaging the sediment.
• Can put in a vendor-provided trailer/container to reclaim filtered water for further handling.	• Need a proper safety for the Personal Protective Equipment (PPE) to the workers. The sediment consists of dangerous hazards which can cause the failure body action of the workers.

III. METHODOLOGY

In the real application where the uses of dewatering bag takes a longer time to achieve the requirement from Depart of Environment (DOE) that must fulfil to achieve 90% removal moisture from suspended solid. For generally purpose, the size of 1m × 1m size takes about 3 to 4 weeks to dry by using the natural heating element (sun) and become the sludge cake. So based on the factor attributes' problem, the new devices (Figure 1) is propose that might be useful for industrial water in term of dryness process for the suspended solid that is attach together towards the dewatering bag.

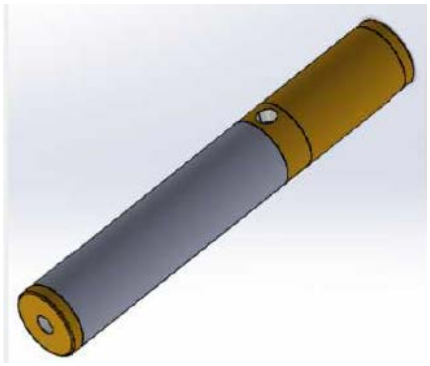

Figure 1. Universal compress air fit (UCAF).

IV. RESULT AND DISCUSSION

A. Theoretical Concept

The concept generation technique and the design is finalized by using the computational fluid dynamics from ANSYS software as a validation technique. This theoretical concept has been approved with tabulation of proven data which shows that this device namely as Universal Compress Air Fit (UCAF) are finally able to produce hot air temperature with average of 43°C that can be up to 51°C.

The product has been fabricated by applying the material concept in order to get the same uniform temperature with the theoretical concept. The material must be maintained at the very high and low temperature. The data will collect and record by comparing the dewatering bag with uses of UCAF and without using UCAF. The data will analyses based on the real application. The final part is by comparing both results.

B. Data Collection

The comparison of the time being to perform sludge cake, uniform temperature, and the moisture level of the sludge per time taken will be analyzed. In order to make it happen, some of the conditions need to be considered like the global weather of the location, a location in Klang Valley. Therefore, the average temperature of the location need to identify for 3 months. Total average temperature is 34.33 °C.

In Klang Valley, Malaysia, it will be the vital temperature reference for this experiment. One of the bags is attach with the propose UCAF device for the sludge cake process and the other one, without using the propose device (Figure 2). Therefore, the data must be taken at the same date and time to get the valid comparison. Both of the dewatering bags using the temperature and moisture device, same procedure but one without using the proposed device UCAF. The efficiency percentage then will be compared.

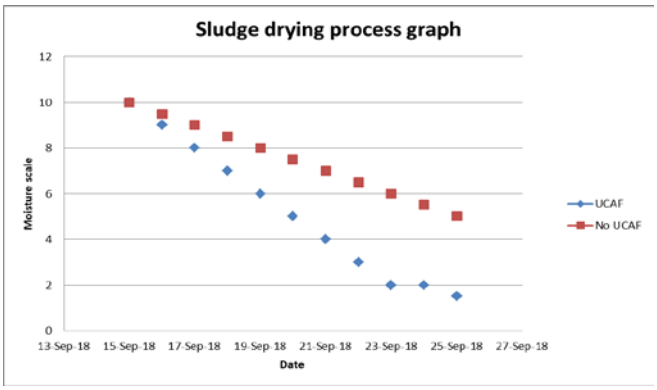

Figure 2. Sludge drying process.

C. *Analysis and Discussion*

Based on the Figure 2 and Table 3, shows that the data that has been collected from September 15, 2018 until 25th. The time taken for every day was determined from 8:00am, 11:00 am, 2:00 pm and 5:00 pm. To measure the sludge contamination, it is measured using moisture scale with the scale from 1-10. So at the first data already shows scale of the sludge is watery and has to be dry until the scale shows the same result (below than 3). The graph shows the data of drying sludge process by using the propose device, UCAF (Universal Air Compress Fit) and without using it. The sludge in dewatering bag tendency to dry faster than usual because getting hot air supply from the UCAF. The results for both are getting different since in first day of experiment, the positive result is getting from UCAF, the moisture level was decrease by 0.5 compared to natural heat, remain at scale of 10. As the final result, the dewatering bag by using the UCAF device shows the moisture scale at 1.5 where at this time another sludge in dewatering bag without using UCAF shows the moisture scale around 5.0 (still watery). At the final data shows the massive different scale between both of the sludge sample at the gap of 3.5.

V. CONCLUSION

As per conclusion, the proposed device, UCAF can be used in the normal condition without depends on weather. The designing idea also generated from the factor attributes (literature review) and designing tools (concept generation and selection). In addition, from the data finding, the UCAF itself can save times in terms of the sludge volumes, it will dry more volume with the less use of times in the future. As the heat temperature apply, the comparison is made by the constant heat temperature can be up to 51^{O}C rather than the natural heat element (sun) which produces up to average of 34.33^{O}C only. So, obviously can be seen that, the more heat applies the faster for the sludge to be dry. For the conclusion, the proposed device, UCAF proves that it can be applied into the real situation that helps the dewatering bag to dry faster without depending on the natural heat, sun. UCAF itself that supply hot air to the sludge can helps the sludge to dry 30% faster than usual. The objective also has been achieved that is to design and develop the factor attributes towards the dewatering devices to the industry.

TABLE III. TABLE OF DATA FOR THE SLUDGE DRYING PROCESS

Date	Time	Moisture scale	
		Using UCAF	Natural Environment (Sun)
Sept 15, 2018	8:00 am	10	10
	11:00 am	10	10
	2:00 pm	9.5	10
	5:00 pm	9.5	10
Sept 16, 2018	8:00 am	9.0	9.5
	11:00 am	9.0	9.5
	2:00 pm	8.5	9.5
	5:00 pm	8.5	9.5
Sept 17, 2018	8:00 am	8.0	9.0
	11:00 am	8.0	9.0
	2:00 pm	7.5	9.0
	5:00 pm	7.5	9.0
Sept 18, 2018	8:00 am	7.0	8.5
	11:00 am	7.0	8.5
	2:00 pm	6.5	8.5
	5:00 pm	6.5	8.5
Sept 19, 2018	8:00 am	6.0	8.0
	11:00 am	6.0	8.0
	2:00 pm	5.5	8.0
	5:00 pm	5.5	8.0
Sept 20, 2018	8:00 am	5.0	7.5
	11:00 am	5.0	7.5
	2:00 pm	4.5	7.5
	5:00 pm	4.5	7.5
Sept 21, 2018	8:00 am	4.0	7.0
	11:00 am	4.0	7.0
	2:00 pm	3.5	7.0
	5:00 pm	3.5	7.0
Sept 22, 2018	8:00 am	3.0	6.5
	11:00 am	3.0	6.5
	2:00 pm	2.5	6.5
	5:00 pm	2.5	6.5
Sept 23, 2018	8:00 am	2.0	6.0
	11:00 am	2.0	6.0
	2:00 pm	2.0	6.0
	5:00 pm	2.0	6.0
Sept 24, 2018	8:00 am	2.0	5.5
	11:00 am	2.0	5.5
	2:00 pm	1.5	5.5
	5:00 pm	1.5	5.5
Sept 25, 2018	8:00 am	1.5	5.0
	11:00 am	1.5	5.0
	2:00 pm	1.5	5.0
	5:00 pm	**1.5**	**5.0**

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