THE EFFICIENCY DECREMENT OF THE SPIRAL PUMP REGARDING THE PIPE COIL DIAMETER

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Abstract. A series of tests were already carried out at an open laboratory to simulate the utilization of tidal or river current to couple the spiral pump to lift up the water to farm areas of about 2- 4 meters above the water level. The tests were conducted on two wheels with coils of different diameters. The first wheel of 46 cm diameter ; 6.6 mm coil pipe diameter; overall length of coil 19 meters; number of wound 16 th, the highest head achieved 4 meters. The second wheel of 46 cm diameter; 8.1 mm coil pipe diameter; overall length of coil 14.3 meters; number of wound 13th; the highest head achieved 5.68 meters. The results comparation shows the efficiency of spiral pump proportional to the pipe diameter size. The smaller the diameter of pipe, the lower the efficiency .

Keywords: *Spiral pump, River current, Efficiency decrement*

I. Introduction

Most farmers in Indonesia utilize the Diesel engine to pump the water to the farm areas mainly in summer. It needs energy and cost, depending on how big the area is, the kind of crop and the length of the dry season. [1,5]. Watering the farm areas by engine creates the problem of production cost higher than normal. The farmers rent the engine and pay the energy for running. This cost is lowering the benefit of farm and reducing the spirit of farming of

the people in Telang II – Banyuasin. This effect is predicted also happen in other swamp farming areas in Indonesia. Lifting the water from the irrigation canal to the farm area of about 2– 4 meters above the canal becomes serious challenge for farmers in order to minimize the energy and cost. Free energy is required to reduce the production cost at the common farm yield. This matter becomes interesting to persuade farmers continually in planting the rice and combat the change of farm land use into industries or settlements [1,5]. It is around 100 thousand hectares of Indonesian agriculture land area converted into industrial

and residential per year[2], which are unwanted by the government. This research was trying to find the utilization of local river and tidal current in form of the simulation. The use of local river and tidal current were predicted would reduce significantly the farming production cost and increase the farmers benefit. The spiral pump usage was ecology friendly and decrease the national fuel consumption. The spiral pump almost free of maintenance, made of basic cheap materials and is relatively easy to made [6]. It works on ancient principle and simple technology.

II. THE SPIRAL PUMP TEST EVER

The spiral pump was first invented in 1746 by H.A.Wirtz, a pewterer of Zurich, Switzerland [4]. A recreated at Windfarm Museum on a 6 ft wheel diameter with polyethylene pipe coil of 160 ft (48 meters) length and 1 ¼ inch (31 mm) diameter. This wheel pump was able to pump 390 gallons of water per day to a 40 ft head with peripheral speed of 3 ft/sec [4]. The spiral pump could work well on the river current of 2 ft/sec or greater. The spiral pump made by John Hermans [6] used a rotating pipe coil to pump water. The pump could pump 400 gallon per day to a tank 50 ft above the pump. The pump was made of 2 scoops, where each scoop has 20 coils of poly pipe of ¾ inch (19 mm) diameter and attached on frame of two meters diameter. On average, the capacity was one liter per minute, but varied from season to season. When this pump was applicable to the Banyuasin tidal farming area, the capacity of pump greatly minimized the farming cost of the people and significantly improved the yield.

Table 1: Indonesian swamp area based on islands *)

Island base	The availablility of swamp area		Developed swamp are (million hectares)	
	Tidal swamp	Non-tidal	Tidal swamp	Non-tidal swamp
Sumatra	6.6	2.7	0.6	0.8
Kaliman	8.1	3.5	0.2	0.4
Irian	4.2	6.3	0.06	0.06
Sulawesi	1.1	0.6	0.02	0.02
Total	20	13.3	0.8	0.47

*)Dit Rawa dan Pantai, Ditjen Pengairan, Dept PU,2009 [3]

Regarding the huge availability of Indonesian tidal farm area, [3,5] the case as found in Banyuasin – South Sumatra, made the utilization of spiral pump became an important idea and logic technology. There were many primary canal and secondary canal on the tidal swamp areas which contain the tidal current. This tidal current was predictively applicable and feasible to couple the spiral pump wheel and lift the water to the area 3 or 4 meters above the canal. It seemed that the application of ancient spiral pump technology supported the national program of diversify domestic energy consumption and decrease the greenhouse gases emissions through developing the renewable energy sources. On the basic of these considerations, the experiments of spiral pump were performed in an open laboratory. The tests were carried out on the wheel of 46 cm diameter. The first test was conducted on the wheel with coil made of 19 meter plastic pipe and 6.6 mm inside diameter and 16th wounds. The second test was conducted on the wheel with coil of 14,3 meters long and 8.1 mm inside diameter and 13th wounds. The scoop of both wheel were the same, the inside diameter was 19.9 mm and the length was 13,2 cm. The coil pipe diameter was similar size from the beginning at the end of scoop (inlet) to the end of coil (outlet).

III. TEST RESULTS AND DISCUSSION

A series of tests encountered the results as presented in Figure 1 and Figure 2. The tests results showed that the coil pipe as small as 6.6 mm and 8.1 mm were able to lift up and deliver the water 2.84 to 5.68 meter high above the pump. The higher head was encountered when the 8.1 mm coil diameter was at the wheel and the delivery pipe was 6.6 mm, the head was as high as 5.68 meter.

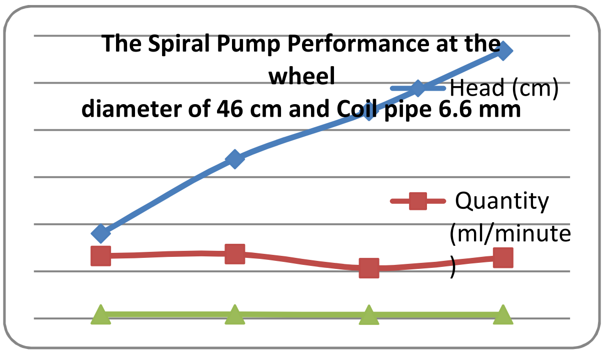

Figure 1: The spiral pump performance at the wheel diameter of 46 cm and coil pipe diameter of 6.6 mm [8]

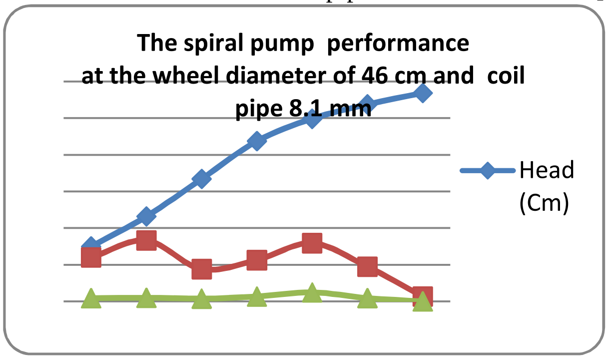

Figure Figure 2:The spiral pump prformance at the wheel diameter of 46 cm and coil pipe of 8.1 mm [8]

. Figure 3. The test apparatus is prepared for used.

These results were compared to the spiral pump of the field scale as developed by H.A.Wirtz in 1746 where the first invented pump could deliver 390 gallons per day but greatly different in head and efficiency. These differences were mainly created by the difference in pipe coil diameter.

Table2. The spiral pump performance comparison between the field pump and the open laboratory test

	H.A.Wirtz (1746)	Darmawi, Riman Sipahutar, Jimmy D Nst.	
Wheel diameter	2 [m]	0.46 [m]	0.46 [m]
Coil pipe diameter	3 [cm]	0.66 [cm]	0.81[cm]
Scoop	7.5 [cm] dia,	1.66 [cm] dia,	1.66 [cm]
	55[cm] long	13 [cm] long	14.2 [cm]
Number of wounds	13	16	13
Peripheral speed	0.9 m/sec	0.28 m/sec	0.35 m/sec
Length of pipe coil	48 m	19 m	14.3 m
Head	12 m	2.84 m	5.68 m
Quantity of flow	14772,73 l/day	86.4 l/day	144 l/day
Efficiency	44 %	4 %	5 – 10 %

Figure 4:The head of pump is raised by enlengthened the supporting pipe.

The test results showed that the very low efficiency and low head of the spiral pump were both at the coil pipe diameter 6.6 mm and at the coil pipe diameter 8.1 mm. These showed that the small diameter of coils pipe the more the greater the friction of the fluid and the bigger energy loss would be. The test results at the diameter coils pipe 8.1mm was slightly better than at the coil pipe 6.6 mm. It clearly showed the influence of pipe coil size on the efficiency and the head of spiral pump. The pattern of water position in the small coils pipe also differed from water position as imagined in large diameter coils pipe. The water in small coil pipe was in broken segments along the circumference of coil rounds which theoretically figured as occupying the below part of coil pipe arc .

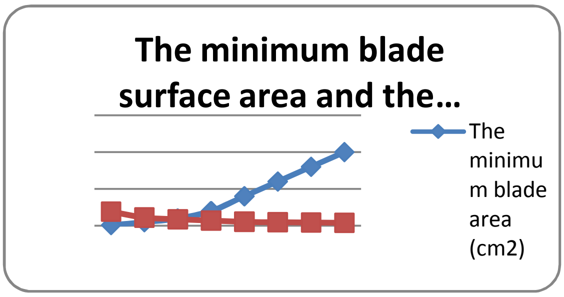

Figure 5. The relation between minimum blade surface area and the available water current for the related performence.[8]

The test results also showed the influence of the current speed also influences the quantity of discharged water, the head achieved and the overall efficiency. The minimum surface area of wheel blade required to be calculated according to the availability of water current for the related test quality. The figures showed the relationship between the blade size and the speed of water. The spiral pump could work at the current speed of 0,8 m/sec. Meanwhile for the tidal turbine, most of the researchers recommended the use of water current of greater than 1 m/sec [3,7].

IV. CONCLUSION

Results were indicated that the spiral pump of small pipe coil diameter reflected the significant decrement of the spiral pump efficiency. The bigger the coil diameter, the shorter the coil used and the better efficiency. The experiments also showed the different pattern of the water inside the pipe, which was segmented along the circumference of the coil pipe and consequently distorted the outflow.

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