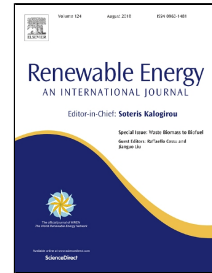


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Experimental Study of Viscosity Effects on a Pump as Turbine Performance

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1 Experimental Study of Viscosity Effects on a Pump as Turbine Performance

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6 7 Abstract

8 An experimental study is carried out to find the effects of viscosity on the performance of a
9 pump as turbine (PAT) system. A pump is tested in an established test rig for five kinds of fluids
10 with different viscosities by the solution of Water-Glycerin with various volume fractions. By
11 analyzing the results of performance tests, two opposite effects are observed. In the part-load
12 region, increasing the viscosity leads to an increase in hydraulic friction losses in the impeller,
13 which decreases the PAT efficiency. On the other hand, at the best efficiency point (BEP) and
14 overload region, by increasing the viscosity, the lubrication effects cause a reduction in the
15 mechanical losses. This effect improves the machine's efficiency. However, at the higher
16 rotational speeds, the hydraulic losses are dominated. Dimensionless correlations for the pure
17 water are compared with other available data in the literature. Three viscosity correction factors
18 for the head, efficiency, and power are obtained, which can be beneficial for selection of a PAT
19 system with the tested viscosity values. Finally, based on the obtained results, a correlation is
20 proposed for calculation of the efficiency as a function of flow coefficient and Reynolds number.

21
22 Keywords: Pump as Turbine; Viscosity; Experimental test; Characteristic Curves

23 24 1. Introduction

25 Nowadays, demand for electricity is continuously increasing. The end of fossil fuels era is
26 predicted shortly while the most portion of generated electricity still relies on fuel based power
27 plants. Due to the limited amount of fossil fuels and their non-renewable characteristics, many
28 countries around the world are expanding their renewable energy strategies, considering future
29 energy safety policies [1].

30 Hydraulic energy is probably the oldest resource which humankind used to generate power. This
31 clean, renewable energy generates 16% of total world electricity and consists of 85% of using
32 renewable energies around the world which is about 20053 TW-h. Hydraulic energy is the main

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