Abstract

A flow distribution in a manifold is widely used in water supply system especially in a Water Pumping Station. The focus of the present work is to identify methodologies capable of perfecting distribution manifold design, to achieve the same rate of mass outflow through each of the lateral pipes. The first part of this study is the experimental work. It covers: a) study of pressure and flow distribution in the manifold to specifically focus on the manifold problem of the baseline models that simulate the distribution manifold of the pumping station (scaled down to 16:1 of the RASAFA Water Pumping Station, b) study of the effect of change in area ratio of three-lateral manifolds, c) study of the effect of change the traditional shape of manifolds from uniform cross section to tapered shape.

The second part is the numerical analysis using the commercial CFD code (FLUENT 14.0) to: a) batter understanding the experimental data, b) determine the optimum taper ratio for tapered distribution manifold before choosing best case for experimental work, c) study the effect of change in area ratio of five-branch manifold, d) study the effect of change distribution manifold inlet diameter of the, e) to study the effect of change in space between each two consecutive laterals, and f) simulate the flow distribution of the manifold of the RASAFA Water Pumping Station in real dimensions.

Each of the methodologies is characterized by geometrical parameters which can be varied systematically in order to attain outflow uniformity. These parameters included: header diameter (50 mm $\leq$ D $\leq$ 150 mm), lateral diameter (25 mm $\leq$ d $\leq$ 75 mm), number of laterals (3 $\leq$ N $\leq$ 5), taper ratio (0.3 $\leq$ TR $\leq$ 1), and the diameter of the distribution manifold inlet (50 mm $\leq D_i \leq$ 90 mm).

The experimental and numerical results have shown that some of these methodologies have given highly satisfactory results to achieve the uniform flow distribution. One of these methodologies is to vary the area ratio of the

manifold. It was found that the area ratio parameter had a makeable effect on the uniformity of the outflow from the manifold where the mass flow rate non-uniformity became 0.4%. This was achieved for an area ratio of 0.14. The second methodology is based on changing the geometrical shape that is a very successful method to improve flow distribution. It was found that the best taper ratio is 0.5 that improves in the flow distribution by (76%) which means is a reduction in the non-uniformity coefficient from 33.6% to 8%.

Finally, over the range of investigated Reynolds numbers, from 50,000 to 200,000, the degree of uniformity of the mass effusion from the laterals was found to be unaffected. The comparison between the experimental and numerical results shows high agreement, and the maximum error was 8%. The comparison of the present numerical and experimental results with the published work gives a good agreement, too.