Chapter 7

Effects of Flow Channel Variations due to Manufacturing and Fouling on Heat Exchanger Performance

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A significant concern with the design of ultra-compact heat exchangers is the impact on performance of flow channel variations due to manufacturing tolerances and fouling effects. As the flow channel diameters are decreased in any design, the impact of flow channel size variations is to decrease both the pressure drop and effectiveness. With flow channel fouling, however, the pressure drop increases with time while the effectiveness decreases with time. It is the purpose of this paper to investigate these performance changes in rotary heat exchangers with both finite manufacturing tolerances and fouling. Measured data, used for manufacturing variations in regenerative wheels, are combined with analytical methods to predict the pressure drop and effectiveness decreases. Fouling, caused by frost growth, is measured indirectly to show how it increases the pressure drop and decreases the effectiveness. The combined effects of manufacturing tolerances and fouling for the flow channels of heat exchangers both play an -important role in altering the performance of heat exchangers. Experimental data and analytical methods are presented in this paper and used to interpret the resulting performance degradation of heat exchangers.

INTRODUCTION

With the development of manufacturing technologies to increase the surface area per unit volume, heat exchangers are manufactured with flow channel hydraulic diameters as small as 0.3 mm for HVAC applications (Shang and Besant 2004). These heat exchangers have a specific surface area of about 4,000 m^2/m^3 and about 40,000 flow channels per m^2 of face area. Kays and