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New Approach in Adsorption Reactor Design for Refrigeration and Heat Pumps Applications

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Abstract

Most adsorbents used in reactors of adsorption refrigeration and heat pump systems are often initially manufactured for different applications namely drinking water treatment, waste water treatment, gas storage, gas and liquid filtration or separation in industrial processes, dehumidification process. Furthermore there will be a requirement of mapping of refrigerant specific uptake against operating conditions mainly temperatures and pressure: this will require to a large number of experimental data for the pair studied (adsorbent-refrigerant) characterisation. Therefore, the adsorbents found in the market will not necessary offer optimum performance for adsorption refrigeration and heat pumps applications. In order to address this issue and in the prospect of manufacturing specific activated carbon adsorbent, a research work is carried out at Warwick University with the objective of screening a large number adsorbent models (more than 60,000) and identifying suitable ones with optimum characteristics for three applications: Ice marking (TC=35°C, TE=–5°C), Air conditioning (TC=35°C, TE=15°C) and Heat pump (TC=40°C, TE=5°C). For each application, the driving temperature will range from 90°C to 250°C. The method consists of using Dubinin-Astakhov modified equation [1] and establishing the maximum refrigerant uptake variation for each application. For this purpose the three key parameters of adsorbent-refrigerant will be varied: xo (maximum uptake of refrigerant by the adsorbent in kg refrigerant per kg of adsorbent) from 0 to 1; K (energetic affinity characteristic of adsorbent-refrigerant pair) from 1 to 50 and n (characteristic of adsorbent micro-pores size distributions) varies from 0 to 6. Overall, the preliminary simulation results show that for each adsorbent model with each application, the refrigerant uptake variation has an optimum (Figure 1). Furthermore and as expected at high temperature, those optima values are tailed off by the maximum uptake of refrigerant xo (Figure 2): it is therefore appropriate and practical to consider 90% to 95% of the value for n and K selection. Figure 3 is an illustration of

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specific cooling capacity for Air conditioning application. Future simulation work will also include evaluation of both heat desorption and heat of adsorption therefore the coefficient of performance (COP). Before any attempting of manufacturing any sample of a given model of activated carbon, further additional work will include simulation performance of a full model of adsorption refrigeration and heat pump systems already available [2, 3].

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