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EFFECT OF PERFORATION DIAMETER ON THE HYDRODYNAMICS OF A SIEVE TRAY

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Extensive literature is available on the working of sieve tray columns. In most of the cases the tray used are either without downcomer; or so small that the liquid flow patterns on the tray are unpresentive of industrial trays. Semi-empirical equations have been used so far, to describe the hydrodynamics conditions on such trays. Therefore, a knowledge of the total pressure drop (h_t) liquid static head (Z_c) and froth height (h_f) under different operating conditions is essential, as they effect both the capacity and stability of the tray.

The experimental apparatus consisting of a large stainless steel column with a downcomer. Two trays i.e. 2' x1' were used, the upper tray being used as test tray. The hole sizes investigate were of 0.5, 0.375 and 0.125

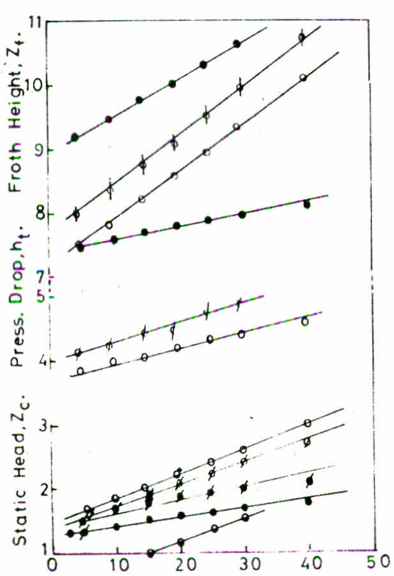

Fig. 1. Plot of static liquid hold up, (Z_c), froth height (Z_f) and total pressure drop (h_t) against liquid flow rates at air flow rate F_A = 2.1

Hole sizes

O – 0.5 inches
ϕ – 0.375 inches
● – 0.187 inches
⧫ – 0.125 inches –. – Data of ref. 2
◒ – 0.062 inches – . – Data of ref. 2

(a) Liquid static head (Z_c)
(b) Total pressure drop (h_t)
(c) Froth height (Z_f)

inches. Details of pressure tappings and methods of measuring froth height and liquid static head on the tray are given in detail elsewhere [1]. For all experiments recirculated air flow rates (F_A 2.1 to 2,5) and liquid flows in the range of 5 to 50 GPM/ft. weir were practised.

During the experiments it was observed that the pressure drop across the tray was inversely proportional to the hole sizes. Fig. 1. This increase in pressure drop across the tray with small hole sizes should be considered carefully as it could limit the tray operation.

It was noticed, that the froth height increases with increasing flow rates [2, 3] (Fig. 1 and 2). With small hole sizes, a stable froth with uniform bubble sizes was noticed. Large sizes of bubbles, which burst quickly and resulted into a lot of entrainment were observed with large hole sizes [4]. Vigorous side to side oscillations of the frothy mass was observed with larger hole diameter, which could lower the tray efficiency and destabilised the stable tray operation.

Static liquid hold up on the tray is a function of hole sizes, and increases with increasing hole diameter Fig. 1.

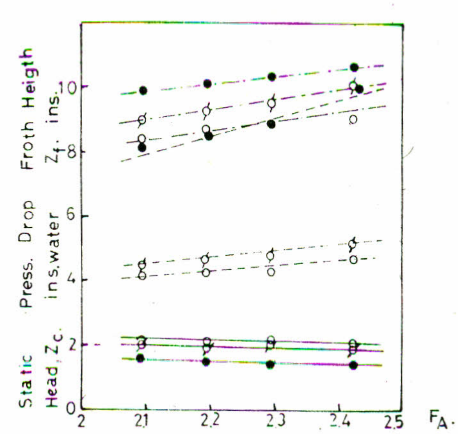

Fig. 2. Plot of static head, total pressure drop and froth height against air flow rates at 18 GPM/ft weir liquid flow rate.

Hole sizes

O – 0.5 inches
ϕ – 0.375 inches
● – 0.125 inches

(a) Liquid static head (Z_c)
(b) Total pressure drop (h_t)
(c) Froth height (Z_f)

This is more probably due to the fact that as the size of the hole increases more liquid is thrown into the froth due to splashing and bursting of large bubble, hence liquid retained in the froth/unit volume is higher with large holes [1,4].

Similarly, a decrease in pressure drop and froth height was observed, with increasing hole sizes when tested with variable air flow rates at 18 GPM liquid rate Fig. 2. This confirmed the results of earlier finding in this study.

An increase in liquid hold up and decrease in froth height with increasing hole sizes are such factors which favours more mass transfer on the tray, which results an increase in tray efficiency [5]. Thus it can be concluded from this study that larger hole sizes (up to 0.5 inches) should improve the performances of a distillation tray.

Key words: Sieve trays, Distillation trays, Separation trays.

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