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SHORTER COMMUNICATIONS

TETRAFLUOROETHYLENE COATINGS ON CONDENSER TUBES

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NOMENCLATURE

h_i, heat-transfer coefficient of cooling water [kcal/m²h degC];
h_o, heat-transfer coefficient of condensing vapour [kcal/m²h degC];
h_R, combined conductance of tube wall and resin coating [kcal/m²h degC];
q, heat-transfer rate [kcal/m²h];
Δt, temperature difference [degC];
U_o, overall heat-transfer coefficient [kcal/m²h degC].

EDWARDS and Doolittle [1], Le Fevre and Rose [2], and Butcher and Honour [3] have discussed the promotion of dropwise condensation of steam with tetrafluoroethylene coatings. Their data shows that the overall heat-transfer coefficient for dropwise condensation is increased from 16

Table 1. *Experimental results*

	Tube	A	B	C
	condensing type	dropwise	dropwise	film type
Steam	q	$1{\cdot}32 \times 10^5 \sim 2{\cdot}24 \times 10^5$	$1{\cdot}49 \times 10^5 \sim 2{\cdot}24 \times 10^5$	$1{\cdot}01 \times 10^5 \sim 1{\cdot}87 \times 10^5$
	Δt	27·5 ~ 56·5	27·5 ~ 56·4	28·2 ~ 57·1
	U_o	5850 ~ 3960	6300 ~ 3960	4110 ~ 3200
	h_i	12900 ~ 6700	12900 ~ 6700	12900 ~ 6700
	h_o	46100 ~ 11300	56200 ~ 11300	8080 ~ 5530
	h_R	25200	25200	175000
CCl_4	condensing type	film type	film type	film type
	q	12000 ~ 29100	11500 ~ 28400	11400 ~ 28700
	Δt	16·7 ~ 56·0	16·7 ~ 55·7	16·7 ~ 55·7
	U_o	720 ~ 520	720 ~ 510	720 ~ 510
	h_i	12900 ~ 5550	12900 ~ 5550	12900 ~ 5550
	h_o	770 ~ 570	780 ~ 570	770 ~ 570
	h_R	25200	25200	175000
CH_3OH	condensing type	film type	film type	film type
	q	20700 ~ 35300	21400 ~ 35800	21600 ~ 35800
	Δt	14·1 ~ 33·9	14·1 ~ 33·6	14·1 ~ 33·7
	U_o	1510 ~ 1040	1580 ~ 1060	1570 ~ 1060
	h_i	12900 ~ 5550	12900 ~ 5550	12900 ~ 5550
	h_o	2020 ~ 1310	2000 ~ 1300	2000 ~ 1300
	h_R	25200	25200	175000

to 30 per cent over that obtained with film type condensation. Practically, however, the cost of the coating is bigger than the saving by the decreased heat-transfer surface area. If tetrafluoroethylene coatings promote the dropwise condensation of organic vapours, as Topper and Baer [4] found for ethylene glycol, nitrobenzene and aniline, the increase of the overall heat-transfer coefficient may be tremendous and the saving will overcome the cost.

The communicators have executed the experiments of condensation of water, carbon-tetrachloride and methanol vapour. The results verified the dropwise condensation characteristic of tetrafluoroethylene for steam, but did not for organic vapours. The experimental data are summarized in Table 1.

Three vertical tubes of aluminum, approximately 1 cm O.D., 50-cm long each were used. Tube A and B had tetrafluoroethylene films, approximately 0·0075-mm thickness, fused to their outer surfaces. Tube C had no resin film on it. Tetrafluoroethylene resin to A is produced by Daikin Industrial Co. and that to B is by E. I. DuPont Co.

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PHOTOGRAPHIC STUDY OF THE INTERFACIAL DISTURBANCES OF LIQUID FILMS IN FALLING FILM FLOW, AND IN VERTICAL, DOWNWARD, ANNULAR TWO-PHASE FLOW

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Liquid film flow is involved in many engineering processes and applications; from cooling and absorption towers to the protection of the nozzles of jet propulsion system, and the film cooling of high speed and re-entry vehicles. Knowledge of the nature and characteristics of the film interface is essential to the understanding of the film itself, the mechanism of flow and the transport phenomena of the flow. In this work, a series of photographs of the interface were taken to reveal typical interfacial disturbances and to explain some relationship between the interfacial disturbances and the flow characteristics.

EXPERIMENTAL EQUIPMENT

A diagram of the experimental equipment is shown in Fig. 1. The test section was made of 2-in I.D. acrylic clear plastic tubing, 126 in. in length. The gas phase flowed to the test section via a 2-in pipe, and had 57 in of straight run before contacting the liquid phase. Liquid was injected into the gas stream through an annular slot at an angle of 4° 38′ to the gas flow direction. The width of the injection slot was kept at 0·0808 in. Photographs were taken at two locations—one centred about 26 in from the liquid injection point, and the other about 74 in from the same point. The coverage of the photographs is about 8 in along the flow direction.

A high frequency Strobolight, used as the light source, was positioned about 45° from the direction of the camera, which was a 4 × 5 Graphic. Kodak Royal X Pan film was used. The exposure was adjusted such that the photographs show a sharp contrast of the interfacial disturbances. The background was kept dark so that only the disturbances on the front half of the tube were photographed.

Compressed air served as the gas phase and water served as the liquid phase. The flow rate of the gas phase varied from zero to 0·415 lb_m/s (corresponding to a velocity from zero to 250 ft/s) and the peripheral liquid flow rate

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