et al., 1985). Their experiments with FT-200 wax at 200°C, using three different SMP distributors (15, 60 and 100 μm) and three different orifice plate distributors (0.25, 0.39 and 0.57 mm) in a 0.032 m ID column, showed that hold-up values were highest with the 15 μm SMP distributor and lowest with the 0.57 mm orifice plate distributor. However, these investigations were carried out for superficial gas velocities less than 0.04 m/s, therefore, the transition from the "foamy" to the "slug flow" flow regime was not observed. The maximum hold-up obtained in the Mobil studies was around 70%, when foam filled the entire column (with the 15 and 60 μm SMP distributors). This value compares well with that obtained with the SMP distributor in the present study.

Experiments conducted with reactor waxes showed no significant effect of distributor type. However, hold-ups obtained using the SMP distributor were marginally higher than those obtained using the 1.85 mm orifice plate distributor in the 0.051 m ID column (see Section V-B.7.).

Experiments with FT-300 and FT-200 waxes conducted to study the effect of distributor type indicate that the effect is most significant in the presence of foam. Smaller orifice diameters and SMP distributors produce higher hold-ups compared to larger orifice distributors. However, in the absence of foam, even though there is a similar trend, its magnitude is rather small. The effect of distributor type is less pronounced in the larger (0.229 m ID) column than in the 0.051 m ID column.

B.6. Effect of Oxygenates

The hydrodynamic behavior of reactor waxes is significantly different from that of paraffin waxes (e.g. FT-200 and FT-300). The reactor waxes, in addition to long chain paraffins, also contain high molecular weight ole-

fins and oxygenates (primarily alcohols and acids). Smith, J. et al. (1984) postulated that oxygenates might be partly responsible for the differences in foaming characteristics between reactor waxes and paraffin waxes. Experiments were conducted in the 0.051 m ID glass column in order to investigate the effect of oxygenates (5 to 10 wt.% of 1-octadecanol and octadecanoic acid) on the hydrodynamic behavior of paraffin waxes. The 1.85 mm orifice plate and the 40 μm sintered metal plate (SMP) distributors were used in these experiments.

The major highlights of these investigations are:

- In the 0.051 m ID column, equipped with the 1.85 mm orifice plate distributor, the addition of oxygenates delayed the breakage of foam to a higher velocity, and a marginal increase in hold-up was observed.
- When the 40 μm SMP distributor was used in the 0.051 m ID column, the addition of oxygenates gave hold-up values which were essentially the same as those for pure FT-300 wax.
- In general, the addition of oxygenates did not have a significant effect on the average gas hold-up.

The experiments were conducted with mixtures of known compositions of 1-octadecanol (99% purity from Sigma Chemical Co.), octadecanoic acid (90% purity from Sigma) and FT-300 wax. All runs were conducted using increasing order of gas velocities at 265°C.

Figure V-29 shows results obtained using the 1.85 mm orifice plate distributor. The hold-up values for all three cases behave as expected, with a substantial increase in gas hold-up as foam is produced, followed by a transition from the "foamy" regime to the "slug flow" regime accompanied

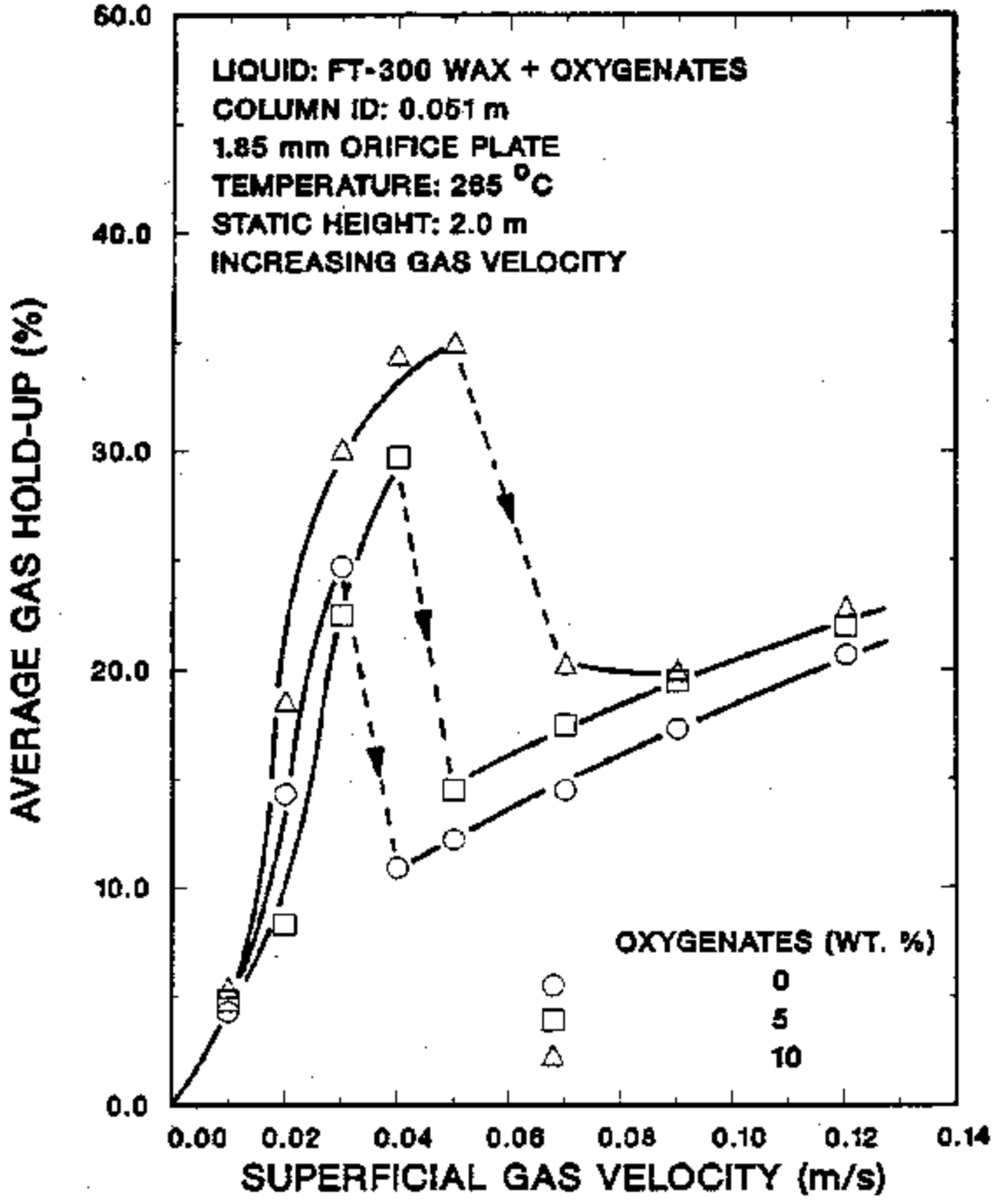

Figure V-29. Effect of oxygenates on gas hold-up (○ - Run 4-1; □ - Run 4-4 - 1-octadecanol; △ - Run 4-5 - equal amounts of 1-octadecanol and octadecanoic acid)

by a sudden decrease in hold-up values. Thereafter, hold-up increases gradually as gas velocity is increased. The transition from the "foamy" regime to the "slug flow" regime shifts to higher velocities as the concentration of oxygenates increases. The maximum hold-up value in the "foamy" regime also increases in a similar manner. In the "slug flow" regime, the hold-ups for runs with oxygenates are marginally higher than those obtained in the run with pure FT-300.

Figure V-30 compares hold-up values for runs made with and without oxygenates using the 40 μm SMP distributor. Once again, these results show trends typical for this distributor, a substantial increase in hold-up to around 70% at lower velocities as foam fills the entire column, followed by a sharp drop in hold-up as the transition from the "foamy" regime to the "slug flow" regime takes place. In the "foamy" regime, hold-up values for the two cases are similar, with slightly higher hold-ups for the wax with oxygenates. These high hold-ups are typical for the SMP distributor for gas velocities in the range 0.02-0.05 m/s. Since coalescence rates for this system are already low, it is possible that the addition of coalescence inhibitors (such as oxygenates) causes no further decrease in coalescence rates. Therefore, oxygenates do not appear to have a significant influence on the hold-up values. However, foam broke earlier for the run with pure FT-300 wax (between 0.04 and 0.07 m/s) compared to run with oxygenates (between 0.07 and 0.09 m/s), but this difference is not significant. The velocity at which the transition from the "foamy" regime to the "slug flow" regime occurred was not always the same in runs with pure FT-300 wax. In some cases this transition occurred at higher velocities (0.09-0.12 m/s,

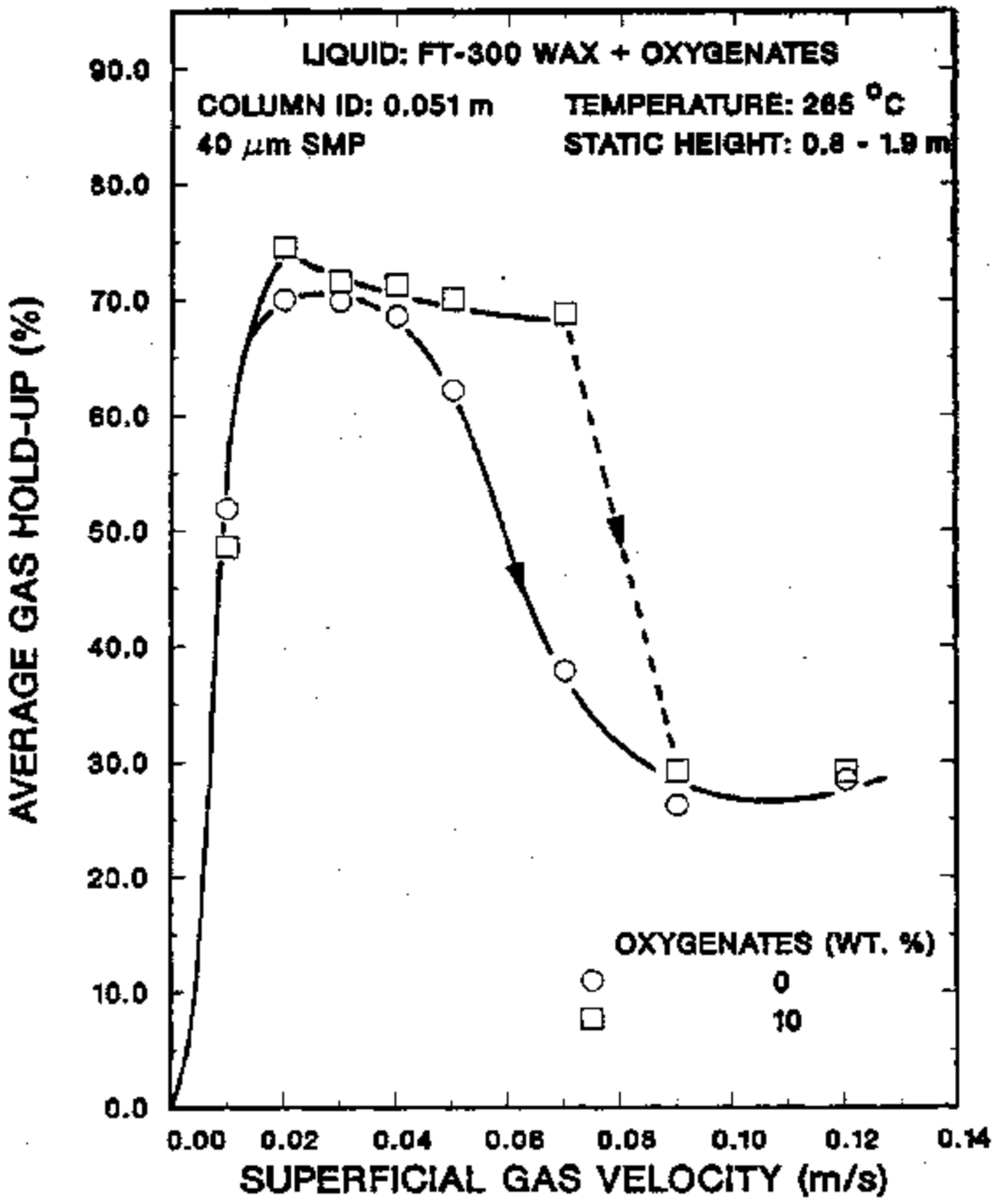

Figure V-30. Effect of oxygenates on gas hold-up (○ - Run 7-2; □ - Run 4-6 - equal amounts of 1-octadecanol and octadecanoic acid)

see Figure V-12). In the "slug-flow" regime, hold-up values for the two runs are similar.

The effect of the addition of oxygenates to FT-300 wax is qualitatively similar to results from studies conducted in the air-water system reported by Schugerl et al. (1977) and Kelkar et al. (1983). Their studies showed that the presence of alcohols in water resulted in higher hold-ups when compared to pure water.

The effect of oxygenates on the hydrodynamic parameters of the FT-300 wax is not significant. From our results it appears that oxygenates do not suppress foaming, and thus the reasons for low hold-ups and absence of foam in experiments with raw reactor waxes, as reported by Smith, J. et al. (1984) and Kuo et al. (1985), are not clearly understood at the present time.

B.7. Effect of Liquid Medium

It has been well established that paraffin waxes have a tendency to foam, the severity of which is dependent on a combination of factors. Bubble size measurements (see Section V-D) have revealed that FT-300 paraffin wax produces bubbles which are significantly smaller than those produced in other systems, such as the air-water system. Experiments were therefore conducted with different liquid media in order to investigate their effect on average gas hold-up. Results obtained with FT-300 wax were compared with those obtained in experiments conducted using FT-200 wax, two reactor waxes (Sasol's Arge reactor wax and Mobil's reactor wax), and distilled water. The investigations were carried out in the 0.051 m and the 0.229 m ID columns at 200 and 265°C with molten waxes, and at room temperature with distilled water. The 1 mm and 1.85 mm orifice plate, and