EXPERIMENTS ON BRINE EXCLUSION WITH FRAZIL ICE PRODUCTION IN OPEN WATERS (ABSTRACT)

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Some wind-generated open waters within the winter sea ice cover, or polynyas, serve as more efficient ice factories than ice-covered areas where sheet ice grows under calm conditions. As brine is excluded during sea ice formation, such high ice production makes shelf water increase its salinity and contributes to the formation process of Antarctic Bottom Water in the Southern Ocean.

To reveal the process of brine exclusion in the polynyas, laboratory experiments were carried out using a test tank (2 m × 0.4 m × 0.6 m) filled with salt water (32 per mill salinity) and set in a cold room. Artificial wind was continuously blown over the water surface from one side after the interior water was cooled to its freezing point. We observed the behavior of the excluded brine due to frazil ice production with a Schlieren optical system, and measured the underwater salinities with an electric conductivity meter. Most excluded brine on the surface was transported downwind through the wind-driven current and then sank to mix with the interior water near the edge of the accumulated frazil ice layer. In the region of the leeward accumulated layer, many brine streamers slowly sank into the underlying water with scarcely any diffusion. The water salinity under the accumulated layer was relatively large and increased as the underlying water was sufficiently mixed. Moreover, in the accumulated ice layer, the mean salinity of the whole layer decreased and the ratio of pure ice increased with time. We can consider that the saline water contained in the layer sank as innumerable ice crystals were crowded by the buoyancy effect. From examination of the experimental results, it is suggested that salt flux to the underlying water due to brine exclusion is great and that convective mixing in the water should be vigorous.

(*Received November 14, 1988*)