How can heavy plastic particles get trapped in ice? Freezing fresh and saltwater in laboratory

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Abstract

Field observations confirm heavy contamination of natural ice with plastic particles, many of which are made of materials with the density larger than that of surrounding water. Apart from aggregation with lighter materials in environment, there are also physical mechanisms favouring this effect. Laboratory experiments are reported which demonstrate how particles from relatively heavy plastics (PS, PET, PA, PU, polymer blend), made from either new market products or weathered beach wrack, get trapped into ice. Synthetic fibers and threads, rigid flakes, flexible films, solid and foamed 3d fragments of the size range of 0.25-60 mm were used, as well as the sets of milled and sieved PS particles of two easily distinguishable colours and size fractions (0.25-0.5 and 1-1.5 mm). Formation of ice from fresh (distilled) and salty (pure NaCl, 34 g/l) water is examined. To mimic natural conditions, the ice was formed via cooling from the surface by air (- 18∘C) in freezing chamber, while at the bottom the heating plate was kept at a temperature, preventing freezing there; side walls were thermally isolated. Temperature at the top and the bottom of the ice/water column, of air and heating plate were controlled automatically. Upon freezing, the ice core was sectioned into 5-cm thick layers, and melted. Location of plastic particles was defined, as well as the meltwater volume and salinity.

In both fresh and salt-water runs, the majority of plastic particles were trapped in ice during its formation and distributed in vertical, with maximum in the middle layers. Two mechanisms are identified responsible for lifting of plastic particles from the bottom: aggregation with air bubbles and convective mixing. No dependency is found of the particle location in the core and its sinking velocity, material density, shape, or size.

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