

# **Ice Concerns for Hydraulic Engineering, Especially in Cold Mountainous Terrain**

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## **Abstract**

**My talk describes and illustrates ice concerns associated with hydraulic engineering for water conveyance systems, especially in cold, mountainous terrain. It aims to draw attention to the potential problems that may occur when water changes from liquid to solid. This propensity for water to change phase is often forgotten by civil engineers designing water-conveyance systems.**

**Hydraulic engineering involves liquid water and the design of open-water channels (and reservoirs) linked to pressurized conduits (pump-lines, penstocks, siphons, and tunnels) that pass water down, up, over, or through mountainous terrain. My talk addresses fundamental aspects of ice formation and behavior in open channels and closed conduits like pipelines and tunnels. An important consideration is the relationship between the freezing temperature of water and flow pressure. Flow pressure can vary substantially in closed-conduit portions of hydraulic systems. The primary engineering concern is that ice formation should not hamper the operation of the system or its component parts. Should a concern arise about the operation of the system, the concern should be mitigated by re-designing the system or its parts, and managing the system by adjusting flow rates, and by monitoring water temperature at key locations. These activities, however, are easier considered than actually implemented.**