Air cushion vehicles – New "lift" for icebreakers

Transport Canada, Bell Aerospace Canada

Followed by spreading ripples of broken ice, the Canadian Coast Guard's Bell Voyageur ACV clears a path on the frozen St. Lawrence River near Montreal. This is an application of the high-speed icebreaking method, especially useful for urban flood prevention and operation in restricted or shallow waters.

Laissant un sillage de glace fracassée, le Bell Voyageur de la Garde côtière canadienne dégage une voie navigable à travers les glaces du Saint-Laurent près de Montréal. La méthode «à haute vitesse» employée dans ce cas est particulièrement utile pour la prévention des inondations dans les zones urbaines et dans les sites difficiles d'accès ou les hauts-fonds.

Following the discovery that air-cushion vehicles break thick ice on rivers and lakes very effectively, Transport Canada and Canadian Coast Guard engineers have developed the promising new technique. In parallel, considerable research and development on ACV icebreaking is being sponsored and promoted by NRC's Associate Committee on Air Cushion Technology.

In March 1976, waters rose rapidly on Quebec's Richelieu River and families were evacuated in the face of what had become a dangerous annual ritual, flooding caused by ice jams on the river. This time, though, things turned out differently. Help arrived in the form of the Canadian Coast Guard's Voyageur, a 20 m (65-ft.) long vehicle riding on a cushion of air. In a few hours, the Voyageur cleared a 14 km ice-jammed stretch of the river, and the next morning the flood subsided.

In just eight days of operations, the Voyageur crew cleared seven ice-jammed rivers around Montreal in another spectacular demonstration of a revolutionary method of icebreaking developed by Canadian scientists over the past few years.

It all started in the winter of 1971/72, in Yellowknife, N.W.T. Arctic Systems Limited, a Calgary-based company, had built the ACT 100, a large air cushion vehicle (ACV), in conjunction with Sun Oil Limited which intended to use it to move heavy oil drilling equipment in the Arctic. While testing out the ACT 100 on the ice of Great Slave Lake at Yellowknife, Sun Oil engineers discovered that it could break fresh water ice up to 68 cm (27 in.) thick at speeds up to 8 km/h. The heavy air cushion vehicle was blowing a bubble of air under the ice and, without the support of water, the ice was collapsing under its own weight. This was the first demonstration of air cushion icebreaking.

The following winter, Ron Wade of Transport Canada's Air Cushion Division ran further icebreaking experiments at Tuktoyaktuk, N.W.T. while testing the ACT 100 for river ferry operations. "We really saw the potential of this discovery for our Coast Guard operations," explains Wade, "and to develop it, an interdepartmental committee was formed with the NRC, the Canadian Coast Guard and other interested government departments.

"At the time, one of the most promising applications of the new icebreaking technique appeared to be placing a heavy ACV platform in front of a ship, so in 1974 some scale model experiments were conducted in an artificial ice tank. We put a scale model of the ACT 100 in front of a model of one of Canada's more powerful icebreakers, the Norman McLeod Rogers, and the results were most encouraging. Unaided, the Rogers can navigate through 46 cm (18 in.) of ice at about three knots, using full power to split and crush the ice. The model tests indicated that with an air cushion attachment, she would be able to navigate in much thicker ice, up to 76 cm (30 in.), at speeds approaching seven knots.

"Eventually, in the middle of 1975, Transport Canada decided to do full scale testing of the principle by mating the ACT 100 with the Alexander Henry, a light icebreaker that normally handles up to 30 cm (12 in.) of ice at two to three knots. Tests in the spring of 1976 at Thunder Bay, Ontario, confirmed the model test results. Without the ACV bow, the Alexander Henry rammed 46 cm (18 in.) thick ice and was rapidly halted in half a ship length. With it, she was able to go continuously through the same ice, at nine knots, using only half power. The ship's captain was very impressed and cleared a track across Thunder Bay Harbor in a quarter of the usual time. The test also showed that only 5 per cent of the fuel required by the unaided ship was needed for the job."

During the same period of time when the new icebreaking method was being investigated, another technique was discovered by accident. The Canadian Coast Guard had been conducting some other icebreaking tests in the Georgian Bay area near Parry Sound, using the Bell Voyageur self-propelled ACV. While proceeding to the test site at 20 to 30 knots, the Voyageur generated such a steep wave in the water below the ice that it broke a swath 30 m (100 ft.) wide, in 51 cm (20 in.) thick ice. Subsequently, the Voyageur was moved to Montreal for general evaluation and in the winters of 1974-75 and 1975-76, the high-speed icebreaking method was further developed. The ship showed that it could clear up to 18 km² of ice an hour, performing in one or two hours a job that would take a conventional icebreaker a whole day. It could also venture where no conventional icebreaker could go because of shallow water, low bridges or power lines.