St. Lawrence TECHNOLOGIES

ABSTRACT

The air quality at indoor skating rinks is an issue of increasing importance for community health departments (CHD), CLSCs, and the public in general. The company MG Service is proposing a solution that will make it possible for municipalities to convert their internal combustion resurfacers to electricity. Electric ice resurfacers have no effect on air quality, and their efficiency and cost savings are superior to conventional models. The technology offers users and taxpayers a more healthy and safe environment, and at very low cost.

The electric propulsion unit was developed jointly by the *Centre d'expérimentation des véhicules électriques du Québec* (CEVEQ) and the engineering firm TPR Inc. This technology is easily integrated into the chassis of conventional resurfacers currently in service.

CLEAN ENERGY

COMMERCIALIZATION OF AN ELECTRIC PROPULSION UNIT FOR ECOLOGICAL ICE RESURFACERS

HIGHLIGHTS

- **Technology**
  - Battery-powered electric propulsion unit designed to replace internal combustion engines.
- **Environment**
  - Eliminates carbon monoxide (CO) and nitrogen dioxide (NO_2) emissions.
  - Exceeds CHD and CLSC recommendations for indoor air quality at skating rinks.
  - Gel-sealed batteries are recyclable, maintenance-free and manufactured in compliance with Underwriters' Laboratories of Canada (ULC) standards.
- **Cost**
  - Electricity is a clean energy source, five times less costly than the fuels now in use.
  - Electric ice resurfacers require very little maintenance.
  - Eliminates need for regular verifications and calibrations to ensure compliance with indoor air quality standards.
  - Reduces ventilation requirements and energy costs associated with aeration of indoor skating rinks.
  - Eliminates tank rental and fuel costs.

Saint-Laurent Vision 2000

Environment Canada Protection Québec Region

Environnement Canada Protection Région du Québec

MG SERVICE

Canada Economic Development

Développement économique Canada

PROJECT OBJECTIVES

The objective of the project initiated by MG Service was to design and produce a battery-operated electric propulsion unit for integration into existing ice resurfacers. The project was intended to convert propane or natural gas resurfacers to electricity.

The engine unit in question had to be:
- non-polluting (atmospheric emissions, noise)
- economical
- efficient
- low maintenance.

The new engine unit had to use a more ecological and easily accessible alternative fuel source that would also contribute to reducing greenhouse gas emissions, in keeping with the Kyoto Agreement.

Another requirement was that the unit must be easily integrated into the chassis of new resurfacers, or serve to convert new or used natural- or propane-gas-powered machines to electricity.

The modified ice resurfacer should also lead to elimin-ating the problems of bad air quality at indoor skating rinks.

BACKGROUND

Faced with growing public concern over the problem of air quality at indoor skating rinks, the development of an alternative to the internal combustion engines in ice resurfacers was becoming a priority. Because the air quality at skating rinks is closely monitored by community health organizations, these buildings are known for the frequency of their elevated levels of CO and NO_2. These contaminants can pose a severe risk of poisoning, especially for those engaged in strenuous physical activity.

In order to reduce these risks, several conventional ice resurfacers were fitted with an electronic system which is able to control but not eliminate emissions. As with any catalytic equipment, system age and maintenance strongly influence efficiency. Toxicity alerts do, therefore, still occur, forcing some skating rinks to shut down.

Gas-powered ice resurfacers have several disadvantages, including their cost. More importantly, the refilling and handling of gas cylinders may be hazardous to operators and the public alike. The cleanest energy source being electricity, the ideal alternative would ensure the uninhibited use of electricity and also allow existing resurfacers to be converted to electric energy.

TECHNOLOGY

Most of the components used in this conversion package have existed for some years and are thus proven and reliable. The new battery-powered unit is made up of the following elements:

Traction engine
- 20 forces, 72 volts
- heavy-duty service
- full-time service
- fixed, tapered drive shaft.

Accessory hydraulic engine
- 10 forces, 72 volts
- heavy-duty service
- full-time service
- fixed, tapered drive shaft direct-drive hydraulic pump.

Speed/instrumentation regulator
- Traction: GE series 100/72 volt potentiometer SCR
- auxiliary hydraulics: GE series 100/72 volt multiple-speed SCR
- full discharge safety system
- complete instrumentation
- transformer of 72–12 volts of direct current for regular component.

Charger
The charger was selected based on rigorous safety criteria:
- ULC-approved
- self-diagnosing
- possibility of partially recharging
- no transformer required.

Batteries
The characteristics of the batteries are as follows:
- maintenance-free (no need for operators to verify cell water levels or to refill them)
- advanced gel-sealed lead batteries (eliminate the risk of explosion when recharging, especially in confined areas, as well as the risk of acid leaks)
- possibility of partially recharging with no memory effect
- five-year warranty
- 600 Ah, $C_{6.}$

The new propulsion unit has the following economic advantages:
- low energy costs (five times lower than natural or propane gas)
- lower fuel costs due to decreased building ventilation requirements
- maintenance costs reduced to a minimum because the components and servicing associated with internal combustion engines have been largely eliminated (tune up, oil change, speed regulator, electric circuitry, engine replacements, gear box, hydraulic pump and transmission, control cable, radiator, hoses, etc.).

RESULTS

The resources of all three project promoters, MG Service, CEVEQ and TPR Inc., were pooled to design the battery-powered unit. A number of constraints had to be eliminated at the outset: the effect of excess weight on the chassis, battery space requirements, and the issue of autonomy of operation. Thanks to MG Service's extensive experience in the area of ice resurfacers, components were selected based on rigorous criteria.

Engineering studies demonstrated that the structure of the existing chassis would be able to support the weight of the batteries. Tires and wheels had to be reinforced, while tire treads were selected to satisfy the new traction requirements.

The size and placement of the battery pack were optimized to facilitate access to it and to ensure adequate autonomy in daily ice-resurfacing operations. Indeed, the battery pack is positioned in such a way to ensure its weight is evenly distributed, thereby greatly improving the machine's gripability and manoeuvrability. The suspension was adapted and a new hydraulic pump was installed.

There are a number of options available to maximize the useful life of the equipment and reduce repair costs:
- polypropylene washing tank (corrosion free)
- hydraulic opening/closing for snow compartment door (to eliminate breakage during snow dumping outside in uneven terrain).

Intensive trials conducted at various indoor skating rinks in Quebec have confirmed the greater-than-anticipated autonomy of machine operation . Whereas initial estimates varied from eight to ten rinks, under ideal conditions, the electric resurfacer can condition 15 ice surfaces consecutively, with no need for partial battery recharging.

The comments of operators are conclusive:
- surface gripability/traction/ manoeuvrability superior to conventional resurfacers
- impression of greater raw power
- very quiet
- very easy to use
- better overall operation than conventional resurfacers.

POTENTIAL AND LIMITATIONS

The new battery-powered unit can eliminate polluting emissions at indoor skating rinks. The purchase of electric resurfacers and the eventual conversion of the conventional resurfacers currently in service will certainly have a beneficial effect on air quality in these buildings. The electric unit also eliminates the risk of accidents associated with the filling, handling and connecting of fuel cylinders. Moreover, there may be major economic spin-offs for municipalities, particularly with respect to savings on purchase, conversion and maintenance costs, and fuel bills, along with the possibility of increased revenue from ice-time rentals and advertising space.

The fleet of ice resurfacers in Quebec and Canada is in very good condition, and the installation of electric propulsion units in these machines is an ideal and cost-effective solution. The only limitations have to do with autonomy of operation. Indeed, extended use of the ice resurfacer in sloping areas and the need to empty snow compartments at distant outdoor locations may be major impediments to such autonomy. The useful life of the batteries is estimated at five years.

INFORMATION

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St. Lawrence TECHNOLOGIES

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