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"Commercial Opportunities in Cryogenic Tire Recycling"

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COMMERCIAL OPPORTUNITIES IN CRYOGENIC TIRE RECYCLING

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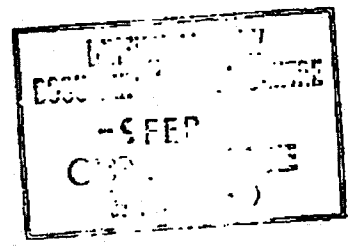

ABSTRACT

The problems facing the tire industry are intimidating. Worldwide, millions of scrap tires are presented each year for disposal. Storage and landfill space is in short supply and is becoming increasingly expensive. To date, few methods have been perfected to handle the scrap tire deluge.

This paper will present the successful sale of 3 systems of Recovery Technologies Inc.'s Reclaprocessor™ 1000 and 2000 Whole Tire Cryogenic Recycling Facility and a description of the processing technology. In addition to the facility sales, this paper will discuss the successful operation of the facility in Cambridge, Ontario which is capable of recycling 1,000,000 tires/year.

One of the barriers to recycling has been the end markets for the rubber granules. The end markets for the Rubber Granules of the Cambridge facility will be detailed along with an overview of the North American market for Rubber Granules and future markets.

PROBLEM OF SCRAP TIRES

Every day approximately 2 million passenger tires are produced worldwide. When they're bald, most of these are either landfilled or burned. Less than 5% of tires are now being recycled. The opportunity is there to provide large quantities of a low cost raw material for use in value added applications.

Globally, we face a serious economic, social, and environmental issue that is rapidly assuming crisis proportions. Disappointingly, the useful properties of rubber are vastly under-utilized when bald tires are simply discarded. Responsible and mature vision dictates the maximizing of this non-renewable resource.

Now, the challenge is one of effective re-use of granulated rubber and other tire components. Focused and innovative research, conducted by RTI, has commercialized a method by which high value rubber, extracted from scrap tires, can re-enter consumer and industrial markets in useful applications.

RECOVERY TECHNOLOGIES CRYOGENIC WHOLE TIRE RECYCLING SYSTEM

Recovery Technologies Inc. (RTI) of Mississauga is a Canadian-controlled corporation that was established in April 1989 following the purchase of a tire recycling facility in Ayr, Ontario. Upon its inception, RTI sought to develop and manufacture energy efficient, cost competitive, cryogenic whole tire recycling systems, for sale on a turnkey basis.

In only four years, RTI has secured sales to Technologies Sistem Tyre of Veroli, Italy, AGA of Switzerland and Groupo Neosa of Mexico. AGA is the fifth largest industrial gas supplier in the world. Groupo Neosa is the largest industrial rubber products manufacturer in Mexico. The facilities in Italy and Switzerland are currently operating in addition to our new operation in Cambridge, Ontario. The Mexican facility is to begin operations in December of this year.

The Reclaprocessor™ 1000 and 2000 Whole Tire Recycling systems offer a commercially proven process for recovering, granulating, and sorting rubber. It features:

- Clean separation of rubber, fibre and steel
- Unaltered chemical composition of the rubber
- Tested and proven technology
- Minimal maintenance and repairs
- Compact and efficient configuration
- Safe, quiet, odour-free performance
- Full conformity with emission and environmental standards
- User access to ongoing technological improvements under a Technology Exchange Agreement

Central to its success is RTI's distinctive five-stage reclamation system for the System 1000:

Stage 1: *Shredding*

Whole passenger and truck tires are delivered by endless belt conveyor to a shredder equipped with a classifier. There, the tires are shredded into chips less than 3" in size.

Stage 2: *Freezing*

Shredded prices are moved up and dropped into the freezing chamber. There, they are brought into direct contact with liquid and gaseous nitrogen and cooled to temperatures below minus 100°F. The brittle, frozen pieces are then gravity-fed into the size reduction unit.

Stage 3: *Fragmentation*

Shredded pieces are fractured into granulated rubber, steel and textile fibre by the size reduction unit. The fractured materials are transported out of the size reduction unit onto a primary separation unit.

Stage 4: *Screening*

The primary separation unit and a moving magnetic separator sort the fibre, steel, and rubber granules. Steel and fibre pieces are separated for recycling. Rubber granules are transported on a conveyor/dryer to remove the moisture. This permits collection of any remaining fibre and sorting of rubber granules by sizes ranging from 5 mesh to less than 200 mesh. Oversize pieces can be returned to the freezing chamber for re-processing.

Stage 5: *Packaging*

The granulated rubber is then packaged in 50-2000 lb. bags in accordance with customer needs. Resulting product is then ready to move to the next stage of processing.

BENEFITS OF CRYOGENIC TIRE RECYCLING

Since the dominating operating cost for the process is the cost of liquid nitrogen, the process has to be efficient in nitrogen usage. Three main factors make this possible:

1. The tire chips are not cooled to liquid nitrogen temperatures of -320°F. Instead, the processing takes place just below the glass transition point for rubber, around -110°F. This reduces the amount of nitrogen consumed without affecting the end-product or power consumption.

2. The freezing chamber is designed to operate as a heat exchanger thereby maximizing the use of the chilling nitrogen vapours. The amount of lost cooling energy, and thus running cost, is reduced dramatically.

3. The insulated freezing chamber has no internal moving parts and no liquid nitrogen bath. This means little maintenance. Even if repairs should be required, the freezing chamber does not have to be thawed avoiding consequent waste of nitrogen.

By cryogenic tire recycling, the following advantages are gained:

Rubber Granules

- Excellent separation of the rubber from the steel and textile.
- Low rubber losses in the process.
- No problem with rubber deterioration due to heat build up.
- Clean rubber surfaces.
- Fine grinding capabilities.

Operating System

* Less electrical power needed for separation.
* Substantially lower maintenance cost because of less wear.
* No fire hazards because of heat build up.
* No air pollution problems.
* Relatively low investment cost.

OPERATING PERFORMANCE

System Capacity: Two-shift operation

	tons
Tires processed	10,000
Rubber granules	6,500
Steel	1,000
Fibre	2,500

* One million passenger car tires/year.
* 225 tires/hour

Typical Rubber Granule Categorization - System 1000

Mesh	*Size (mm)*	*%*
3/8"-1/4"	9-5	5
4-10	5-2	34
10-20	2-0.85	35
20-30	0.85-0.425	14
30-40	0.60-0.425	5
40-	<0.425	7

Variable Operating Costs

6 - 7 cents/lb.

Capital Cost

$2.0 million USD

Pay Back Period

3 years

Electrical Consumption

250 kW/hour

545 Hp

Nitrogen Consumption

Primary freezing chamber

0.50 lbs liquid nitrogen/lb tire input

Operating Personnel

3 operators per shift

1 supervisor per shift

Space Requirements

300 m^2 floor space

22 ft overhead clearance

SYSTEM 2000

The System 2000 can be added on to a System 1000. It is a secondary cryogenic system that is capable of taking raw material of 4-10 mesh and 10-20 mesh and reducing it to a size of 20 mesh and finer as shown below:

TYPICAL RUBBER GRANULE CATEGORIZATION - SYSTEM 2000

Mesh	*Size (mm)*	*%*
3/8"-1/4"	9-5	0
4-10	5-2	0
10-20	2-0.85	0
20-30	0.85-0.60	15
30-40	0.60-0.425	33
40-60	0.425-0.250	32
60-80	0.250-0.180	15
80-	<0.180	5

NORTH AMERICAN MARKET FOR RUBBER GRANULES

The following is an estimate of the rubber granules market segmented by industry for 1993 and the forecasted market for 1997:

	1993	1994
Market Segment	*Quantity (lbs)*	*Quantity (lbs)*
Molded Rubber Products	63,000,000	92,000,000
Automotive/Tires	55,000,000	82,000,000
Asphalt Rubber	39,000,000	2,000,000,000
Sports Surfaces	22,000,000	32,000,000
Consumer Rubber Products	11,000,000	14,000,000
Friction	7,500,000	8,200,000
Plastic/Rubber	5,500,000	8,000,000
Total	**203,000,000**	**2,236,000,000**

Molded Rubber Products

Rubber granules is formed into a set shape, typically held together by an adhesive material or combined with another polymer (urethane). Examples of this application are railroad crossing pads, dock bumpers, patio floor blocks, flooring material, roof walkway pads and carpet underlay.

Automotive/Tires

Rubber granules are used as a high grade extender in passenger, truck and other pneumatic tires. Though used only in small quantities, it is a significant market due to the large number of tires produced each year.

Asphalt Rubber

Rubber granules in the form of CRM (Crumb Rubber Modifier) is blended with asphalt to modify the properties of this material when used for highway construction, crack and joint sealant, roofing materials, liners and covers for containment ponds and waste disposal facilities.

SPORTS SURFACES

Rubber granules are used either in the supporting structure for the playing field or mixed with the material that comprises the running track surface. Rubber granules make the playing surface and the running track more resilient, and less rigid, while allowing the surface to maintain traction and shape.

FRICTION

Friction brake materials incorporate rubber granules in their makeup as a property modifier in brake pads and brake shoes.

PLASTIC/RUBBER

Rubber granules can be added in large quantities to extend or modify the properties of polymeric materials. Most often used in a thermoplastic vehicle, end products include injection molded parts and extruded sheet goods and hoses.

RUBBER GRANULES MARKETS FOR CAMBRIDGE FACILITY

Market Segment	*Quantity (lbs)*
Sports Surfaces	2,000,000
Construction/Sealants	1,050,000
Rubberized Asphalt	3,500,000
Rubber products	1,300,000
Tires/Automotive	3,600,000
Plastic/Rubber	700,000
Total	**12,150,000**

FUTURE MARKETS FOR RUBBER GRANULES

RUBBERIZED ASPHALT

Use of rubber granules as an additive in asphalt formulations for highway applications represents a large potential market. On December 18, 1992, President Bush signed into law the Surface Transportation Act which has the following regulation on asphalt rubber:

USE OF ASPHALT PAVEMENT CONTAINING RECYCLED RUBBER

(1) STATE CERTIFICATION

Beginning on January 1, 1995, and annually thereafter, each State shall certify to the Secretary that such State has satisfied the minimum utilization requirement for asphalt pavement containing recycled rubber established by this section. The minimum utilization requirement for asphalt pavement containing recycled rubber as a percentage of the total tons of asphalt laid in such State and financed in whole or part by any assistance pursuant to title 23, United States Code, shall be:

(A) 5 percent for the year 1994
(B) 10 percent for the year 1995
(C) 15 percent for the year 1996
(D) 20 percent for the year 1997 and each year thereafter.

According to the National Asphalt Paving Association (NAPA), approximately 500 million tons of hot mix (HMA) are produced annually. Assuming 20% of this HMA amount is applied to federally funded road projects and if we use 20 pounds of crumb rubber additive (CRA), we can calculate anticipated demand for CRA in 1997 when the Surface Transportation Act takes full effect. Thus 2 billion pounds of CRA will be required in 1997.

This is a potential market for 140 Whole Tire Recycling Facilities at 1,000,000 tires/year in the United States alone to meet this legislation.

RUBBER/POLYURETHANE BLENDS

The benefits of the legislation of rubberized asphalt is that large quantities of rubber granules will be available. The availability or large quantities of rubber granules will lead to the future development of value-added products. Two such applications have been developed in Ontario that have the potential.

Domal Envirotech

Domal Envirotech has designed, developed and manufactured a rubber manhole transition collar and rubber riser for installation on top of and underneath the manhole frame. Each rubber transition collar would consume 26 used tires and each rubber riser would consume 10 tires.

Benefits:

- Rubber absorbs the action of expansion and contraction.
- Rubber absorbs the impact of vibration.
- Rubber prevents moisture infiltration.
- Rubber compensates for soils movement.
- Rubber provides skid resistance for vehicles.
- Rubber will reduce maintenance costs.

Enviroblock Surfacing Systems Canada Inc.

Enviroblock has developed an interlocking paving stone made of recycled rubber granules, waste asphalt pavement and waste plastics. The Enviroblock project is, in part, sponsored by Exxon. The Enviroblock stones (bricks) are paving material for surfacing application competing directly with pavement interlocking stones and can be used for driveways, parking lots, sidewalks, traffic islands, and cross walks.

Rubber Plastic Blends

There is opportunity for growth of rubber plastic blends from whole tires in the automotive industry as a low cost replacement for thermoplastic elastomers. Aquapore Moisture Systems has had success with it soaker hose product. Horizon Plastics of Ontario has had quite a bit of success with its rubber/plastics composter.

SUMMARY

Recovery Technologies development of a whole tire recycling system and equipment secures a technique that is reliable and can operate at a low total cost.

Tire recycling can now be approached as a business opportunity. The growth in asphalt and value-added products will one day lead to 100% recycling of this valuable raw material.