SMP INVENTION DISCLOSURES

DISTRIBUTION AND PIPELINE TECHNOLOGY

95-1362 • Pressure Invariant Gas Safety Shutoff Valve

96-1388 • NFM Process for Removal of Impurities From Gas Streams (CLOSED)

97-1394 • Acoustic Locator

97-1401 • An Ultra-Low Power Method of Transmitting Information (CLOSED)

97-1402 • Customer Account Display Enhanced Thermostat

00-1447 • Electronic Marker for Buried Valve

05-1610 • Noise Reduction and Estimation of Pipeline Signals

06-1656 • A Device for Locating Cast Iron Joints

ENVIRONMENTAL SCIENCE & FORENSIC CHEMISTRY

96-1380 • Use of Sodium Citrate as Chelator for Enhancement in Fenton's Reaction

00-1451 • Thermochemical Solidification of Dense Nonaqueous Phase Liquids at Contaminated Sites – (Patent #6,945,734 9/20/05)

00-1468 • A Novel Method of Operation of Zero Head Space Conditions for Volatile and Semi-Volatile Compounds for Partitioning and Contaminant Release Rate Determination (APPLICATION PENDING)

05-1638 • Rapid Quantification of Butyric Acid Producing Bacteria – Real Time using PCR

05-1639 • Rapid Quantification of Acetic Acid Producing Bacteria – Real Time using PCR

ENERGY UTILIZATION

94-1350 • A Simplified Air-Cooled Lithium Bromide Absorption Air Conditioner Utilizing Sprays (Abandoned)

95-1369 • Staged Combustion Utilizing Forced Internal Recirculation (CLOSED)

97-1393 • High-Efficiency, Low-Pollutant Emission Cyclonic Firetube Boiler (CLOSED)

99-1431 • Advanced Forced Internal Recirculation Burner (CLOSED)

99-1434 • Self-Recuperated, Low-NO_x Flat Radiant Panel

00-1440 • Novel High Efficiency Deep Fryer (CLOSED)

00-1441 • High-Efficiency Ultra Low-Emission Boiler/Heater

00-1443 • Bakery Oven Steam Generator

02-1485 • Method for Locally Deploying Pipeline Protection Compounds (CLOSED)

02-1523 • Combustion –Based Emission Reduction (CBER) method & System (APPLICATION PENDING)

03-1526 • Multi-Ported, Internally Recuperated Nozzles for Direct Flame Impingement Heating (APPLICATION PENDING)

03-1545 • Burner Utilizing a High-Heat Transfer Low-NOx Oxygen-Fuel Combustion System (Patent #6,939,130 9/6/05)

03-1548 • Process and Apparatus for Unicorn Combustion within a molten material (APPLICATION PENDING)

03-1571 • Method and Apparatus for Enhanced Heat Recovery from Steam Generators and Water Heaters (APPLICATION PENDING)

04-1582 • Method and Apparatus for Heat and Mass Transfer Augmentation (cofunded with DOE and GRI)

05-1619 • Intelligent Operator CHP Control Systems for Engine Driven Generator Set

05-1617 • Automation Device Used to Fill a Volume Given Pressure with a Compressible Fluid

SMP PATENTS

DISTRIBUTION AND PIPELINE TECHNOLOGY

80-928 • **Sonic Detection of Gas Leaks in Underground Pipes (EXPIRED)**
-- U.S. Patent No. 4,455,863 (June 26, 1984).
Inventors: James E. Huebler and Jeffrey M. Craig.

Abstract: An apparatus and process for locating gas leaks in underground pipelines by detection of sound waves created by the leaking gas. The Apparatus and process uses a sound transducer attached to an elongated probe inserted in the ground for a substantial portion of its length. The passive sonic detection apparatus and process of this invention provides improved sensitivity for detection of sounds created by leaking gas and thereby more accurate pinpointing of the gas leak in an underground pipeline.

87-1096A • **Interchangeable Automated Porting Valve and Assembly**
--U.S. Patent No. 4,987,924 (January 29, 1991).
Inventors: William F. Rush, Dennis L. Sadowski and Hyman A. Todres.

Abstract: Covers a remotely-operated plug valve capable of being repaired or modified in place. The use of several plug valves results in a parallel porting valve assembly.

88-1161 • **Method and Apparatus for Injecting Acoustic Signals Into Live Gas Mains**
-- U.S. Patent No. 5,027,644 (July 2, 1991).
Inventors: Christopher J. Ziolkowski and James E. Huebler.

Abstract: A modified pressure regulator concept is used to inject acoustic signals into pressurized gas mains. Such signals can be used to locate piping or help in mapping distribution systems.

89-1175 • **Process and Apparatus for Insertion of Robots in Gas Distribution Systems**
-- U.S. Patent No. 5,660,202 (August 26, 1997).
Inventors: William F. Rush, Jr., Bruce K. Campbell, Kenneth C. Hardy and Lynn A. Sweetwood.

Abstract: A hot tap apparatus for insertion of a controllable device into an in-service pipeline. The insertion end of the housing is sealable. The apparatus includes cutting apparatus for cutting an opening in the pipe sized to receive the controllable device disposed in the housing.

SMP PATENTS (Cont.)

96-1384 • **Method for Application of Protective Polymer Coating**

-- U.S. Patent No. 6,146,709 (November 14, 2000); Applications filed in Mexico and Canada Patent No. 2,263,038 (1/25/05)

Inventors: Joseph M. Katz, William F. Rush, Jr., Victor Tamosaitis

Abstract: A process for application of a protective coating to a steel, concrete, or wooden structure so as to provide protection against corrosion, weathering, or other environmental damage in which the surface to be protected is heated to a temperature in a range of about 75°F. to about 150°F. after which a liquid thermoset primer is applied to the heated material in two stages. The first portion is solidified by heating and then coated with a second portion, forming an uncured liquid thermoset outer primer layer. A melted polymer powder layer is then applied by flamespraying over the uncured liquid thermoset primer layer, forming an intermediate polymer powder layer embedded in the uncured liquid thermoset primer layer. The intermediate melted polymer powder layer is then heated to a flow temperature of the polymer powder and a second layer of melted polymer powder is applied over the intermediate polymer powder layer, which then cools to form the final protective coating.

97-1390 • **Remote Cathodic Protection Monitoring System**

-- U.S. Patent No. 5,999,107 (December 7, 1999); Applications filed in European Patent Office.

Inventors: Joel Cooper, Albert W. Gershman, Joe W. McCarty, Arthur Shapiro and Christopher J. Ziolkowski

Abstract: A cathodic protection monitoring system for metal objects comprising a transponder, a sacrificial anode and a reference electrode buried underground in close proximity to the buried metal object to be protected. The system further comprises a portable transceiver disposed above ground tuned to a frequency of the transponder. Power for the operation of the transponder is drawn from the cathodic protection circuit, thereby obviating the need for connections to above ground power supplies.

99-1432 • **Enhanced Acoustic Detection of Gas Leaks in Underground Pipes Boxes**

-- U.S. Patent No. 6,725,705 (issued 4/27/04).

00-1448 • **Electronic Marker for Metallic Valve Covers**

-- U.S. Patent No. 6,690,278 (issued 2/10/04).

ENVIRONMENTAL SCIENCE & FORENSICS

91-1272 • **Cyclonic Thermal Treatment and Stabilization of Industrial Wastes**

-- U.S. Patent No. 5,307,748 (May 3, 1994) and Canada Patent No. 2,109,995 (June 16, 1998).

Inventors: Mark J. Khinkis and Hamid A. Abbasi.

Abstract: A process and apparatus for thermal treatment and stabilization of waste materials in which waste material is introduced into an uppermost first combustion zone of a vertically oriented combustion chamber and a fuel and an oxidant are tangentially injected into the first combustion zone, oxidizing at least a

portion of any organic material in the waste materials and melting at least a portion of any inorganic material in the waste materials. .

SMP PATENTS (Cont.)

90-1229 • **Integrated Chemical/Biological Treatment of Organic Waste**

-- U.S. Patent No. 5,610,065 (March 11, 1997);
Inventors: Robert L. Kelley, Andy H. Hill, Vipul J. Srivastava, W. Kennedy Gauger and John J. Kilbane.

Abstract: A process for improved remediation of polynuclear aromatic hydrocarbon and/or polychlorinated hydrocarbon contaminated materials by integrated chemical/biological treatment comprising contacting the organic waste with hydrogen peroxide in the presence of ferrous ion oxidizing the organic waste and producing more readily biodegradable hydrocarbon product materials, and then biodigesting the product materials by aerobic and/or anaerobic biodigestion.

92-1279 • **Adsorption of PCBs Using Biosorbents**

-- U.S. Patent No. 5,750,065 (May 12, 1998).
Inventor: John J. Kilbane, II.

Abstract: A method for producing biosorbents for adsorption of PCB's in which at least one proteinaceous material is contacted with a molar excess of at least one PCB congener mixture, forming a protein/PCB congener mixture. The protein/PCB congener mixture is dried after which the PCB congeners are extracted from the dried protein/PCB congener mixture forming a biosorbent in the form of an imprinted protein.

95-1363 • **Sequential Biological/Chemical/Biological Treatment of Organic Wastes**

-- U.S. Patent No. 5,955,350 (September 21, 1999).
Inventors: Bhupendra K. Soni, Kevin Kayser, Robert L. Kelley and Vipul J. Srivastava.

Abstract: A process for remediation of contaminated solid materials comprising polynuclear aromatic hydrocarbon contaminated solid materials, polychlorinated hydrocarbon contaminated materials, and mixtures thereof by sequential biological/chemical/biological treatment.

00-1467 • **The Use of Vapor Pressure Characterization to Identify Sources of Rapidly Released Contaminants at Contaminated Sites**

-- U.S. Patent No. 6,591,702 (issued 7/15/03).

ENERGY UTILIZATION

86-1090 • **Process and Apparatus for High-Temperature Combustion (Abandoned)**

-- U.S. Patent No. 4,828,481 (May 9, 1989).
Inventors: Sanford A. Weil, Tian-yu Xiong and Donald K. Fleming.

Abstract: Covers a process and apparatus for high-temperature combustion in a combustion chamber with two opposed porous plates, whereby increased combustion temperatures are achievable through internal radiant energy recuperation. The high-temperature combustion apparatus and process can achieve superadiabatic combustion temperatures that are especially suitable for applications such as waste disposal and incineration.

SMP PATENTS (Cont.)

85-1069 • **Fuel Combustion**

-- U.S. Patent No. 4,846,665 (July 11, 1989).
Inventors: Hamid A. Abbasi.

Abstract: Process and apparatus for fuel combustion providing oscillation of fuel or combustion air provided to a burner to generate successive fuel-rich and fuel-lean zones in a flame thereby reducing NO_x emissions.

82-987 • **Vertical Shaft Melting Furnace and Method of Melting**

-- U.S. Patent No. 4,877,449 (October 31, 1989).
Inventor: Mark J. Khinkis.

Abstract: A vertical shaft, melting furnace wherein meltable solids are charged to the upper region of a bed supported only by a fluid cooled support grid having openings smaller than the average diameter of the charged solids. Submerged combustion is maintained in a melt pool below the bed of solids and combustion product gases are passed upwardly through the bed of solids preheating and melting a substantial portion of the solids.

87-1091 • **Ultra-Low Pollutant Emission Combustion Process and Apparatus**
87-1091A

-- U.S. Patent Nos. 5,013,236 (May 7, 1991) and 5,158,445 (October 27, 1992); for the latter see also Japan Patent No. 2,619,973 (March 11, 1997).
Inventor: Mark J. Khinkis.

Abstract: An apparatus and method for ultra-low pollutant emission combustion of fossil fuel wherein an elongated cyclonic primary combustion chamber introduces the first fuel portion of about 1 percent to about 20 percent of the total fuel and primary combustion air. A second fuel portion is introduced into the secondary combustion chamber with secondary combustion air. In preferred embodiments, cyclonic flow is maintained through the combustor. This device is ideal for direct air heating applications.

87-1125 • **Process and Apparatus for Emissions Reduction From Waste Incineration**

-- U.S. Patent No. 5,020,456 (June 4, 1991); Canadian Patent No. 2,036,944 (September 19, 1995); and Japan Patent No. 2,026,049 (February 26, 1996).
Inventors: Mark J. Khinkis, Hamid A. Abbasi, Robert A. Lisauskas and Daniel C. Itse.

87-1125B

--U.S. Patent No. 5,205,227 (April 27, 1993).
Inventors: Mark J. Khinkis and Hamid A. Abbasi.

87-1125BD

-- U.S. Patent No. 5,307,746 (May 3, 1994).
Inventors: Mark J. Khinkis and Hamid A. Abbasi.

Abstract: A process and apparatus for combustion of waste such as municipal solid waste, refuse derived fuel or other comparable solid waste. Natural gas injection into the combustor chamber and flue gas recirculation (for mixing) are used to simultaneously reduce nitrogen oxides, carbon monoxide, chlorinated hydrocarbon and other emissions. The process has been termed METHANE de-NOX.SM

SMP PATENTS (Cont.)

87-1125A • **Process and Apparatus for Reducing Pollutant Emissions in Flue Gases**
-- U.S. Patent No. 5,105,747 (May 26, 1992) and Japan Patent No. 2,643,720 (May 2, 1997).
Inventors: Mark J. Khinkis, Jitendra G. Patel, and Amirali G. Rehmat.

Abstract: A combustion process and apparatus for simultaneously reducing nitrogen oxides, sulfur oxides and hydrogen chloride in a high temperature furnace. A combustible material is introduced and combusted within the furnace, forming a primary combustion zone. Combustion air, sorbent and a first portion of hydrocarbon fuel are mixed and combusted within a calciner to form a product gas/calcined sorbent mixture. The product gas/calcined sorbent mixture and a remaining portion of fuel are injected into the furnace, forming an oxygen deficient secondary combustion downstream of the primary combustion zone. Overfire air is injected into the furnace, forming an oxidizing tertiary combustion zone downstream of the oxygen deficient secondary combustion zone. The process has been termed METHANE de-TOX.

86-1088 • **Temperature Measuring Pyrometer Probe That Compensates for Radiation Heat Transfer and Pneumatic Losses (Abandoned)**
-- U.S. Patent No. 5,116,137 (May 26, 1992).
Inventors: Tian-yu Xiong and Lloyd McHie.

Abstract: An apparatus and process for a temperature measuring pyrometer probe that measures gas temperatures above the melting point of conventional thermocouple material. The apparatus is used to calculate radiation heat losses and compensate for pneumatic cooling from the thermocouple junction of the pyrometer probe. A thermocouple junction is mounted within a throat section of a nozzle. The pyrometer probe is intermittently cooled with gas by pulsing reverse cooling gas flow through the pyrometer probe. A computing system calculates radiation heat transfer losses, pneumatic cooling of the pyrometer probe, and instantaneous gas temperatures.

92-1294 • **Method for Two-Stage Combustion Utilizing Forced Internal Recirculation**
-- U.S. Patent No. 5,350,293 (September 27, 1994).
Inventors: Mark J. Khinkis, H. Abbasi, and David F. Cygan.

Abstract: A method and apparatus for two-stage combustion in which a mixture of fuel and primary combustion air is burned in a primary combustion zone, the primary combustion air comprising less than a stoichiometric requirement for complete combustion of the fuel, and where a portion of cooled partial combustion products formed in the primary combustion zone is recirculated. Additional combustion air is introduced into a secondary combustion zone.

SMP PATENTS (Cont.)

88-1166 • **Process and Apparatus for Cyclonic Combustion**
88-1169A

-- U.S. Patent No. 5,462,430 (October 31, 1995) and Japan Patent No. 2,662,175 (June 13, 1997).
Inventor: Mark J. Khinkis.

Abstract: A process and apparatus for cyclonic combustion with ultra-low pollutant emissions and high efficiency wherein a fuel and primary combustion air mixture is tangentially injected into a reducing primary combustion zone of a cyclonic combustor. Secondary combustion air is tangentially injected into an oxidizing secondary combustion zone of the cyclonic combustor. Primary combustion products from the reducing primary combustion zone are mixed with the tangentially injected secondary air for completing combustion within the oxidizing secondary combustion zone. The walls of both zones are cooled, making this device ideal for watertube boilers.

87-1126 • **Low Pollutant-Emission, High-Efficiency Cyclonic Burner for Firetube Boilers and Heaters**
87-1127
87-1131
87-1132

-- U.S. Patent No. 5,209,187 (May 11, 1993).
Inventors: Mark J. Khinkis.

Abstract: A low pollutant emission, high efficiency cyclonic burner and cyclonic combustion process for firetube boilers and heaters in which the combustion air required for complete combustion is introduced into the cyclonic burner in stages.

91-1254 • **Oxygen-Enriched Combustion Method**

-- U.S. Patent No. 5,203,859 (April 20, 1993); Canada Patent No. 2,094,690 (June 16, 1998); and EPC (France, Germany, Italy, and United Kingdom) Patent No. 567131B1 (December 11, 1997); Application filed in Mexico.
Inventors: Mark J. Khinkis and Hamid A. Abbasi.

Abstract: A process and apparatus for oxygen-enriched combustion of a fuel in an industrial furnace in which a preheated primary oxidant from a heat exchanger and a fuel to be combusted are introduced into a combustion chamber and ignited. A secondary oxidant having an oxygen concentration in excess of the concentration of oxygen in air is introduced into the combustion chamber downstream of the flame, submerged combustion, and the resulting combustion products are exhausted. This process has been termed OEAS.

87-1126 • **Cyclonic Combustion**
87-1127
87-1131
87-1132A

-- U.S. Patent No. 5,220,888 (June 22, 1993); and Japan Patent No. 2,955,432 (July 16, 1999)
Inventors: Mark J. Khinkis and Hamid A. Abbasi.

Abstract: A process for cyclonic combustion whereby fuel and oxidant are mixed prior to injection into the combustion chamber. This device is ideal for firetube boilers.

SMP PATENTS (Cont.)

92-1293 • **Gas-Fired, Porous-Matrix, Surface Combustor-Fluid Heater**

-- Canada Patent No. 2,127,742 (May 20, 1997) Abandoned 5.30.01; Japan Patent No. 2,688,325 (August 22, 1997) Abandoned 5.30.01; and Korea Abandoned: Patent No. 240836 (October, 29, 1999)

Inventors: Mark J. Khinkis and Tian-yu Xiong.

Abstract: A porous matrix, surface combustor-fluid heating apparatus that includes a combustion chamber with a cooled flow distributor supporting a stationary porous bed within the combustion chamber, porous bed heat exchanger means embedded in the stationary porous bed and a means for introducing a fuel/oxidant mixture into the bed. Said fuel/oxidant mixture burning in the stationary porous bed.

94-1337 • **Staged Combustion in a Porous-Matrix Surface Combustor to Promote Ultra-Low NO_x Emissions**

94-1293B

-- U.S. Patent No. 5,476,375 (December 19, 1995); Mexico Patent No. 188,857 (May 7, 1998); and France Patent No. 9,512,285 (October 9, 1998); Canada Patent No. 2159870 (February 13, 2001)

Inventors: Mark J. Khinkis, Hamid A. Abbasi, and Thomas D. Briselden.

Abstract: A porous matrix, surface combustor-fluid heating apparatus in which combustion of a fuel/oxidant mixture is carried out in stages within a stationary porous bed disposed in a combustion chamber. A fuel-rich fuel/oxidant mixture is burned within a region of the stationary porous bed disposed near the inlet end of the combustion chamber, forming a primary combustion zone. A secondary oxidant is introduced into the stationary porous bed downstream of the primary combustion zone forming a secondary combustion zone. Finally, heat resulting from the combustion is removed by fluid flowing through heat exchanger tubes embedded within the stationary porous bed.

92-1293A • **Gas-Fired, Porous-Matrix, Combustor-Steam Generator**

-- U.S. Patent No. 5,544,624 (August 13, 1996).

Inventor: Tian-yu Xiong.

Abstract: A porous matrix, surface combustor-fluid heating apparatus, as practiced in U.S. Patent No. 5,476,375, that uses at least one vertically oriented, fluid-cooled tube within the porous bed.

93-1320A • **High-Heat Transfer, Low-NO_x, Oxygen-Fuel Combustion System**

-- U. S. Patent No. 5,725,366 (March 10, 1998);

Inventors: Mark J. Khinkis, Hamid A. Abbasi and Roman E. Grosman.

Abstract: A process and apparatus for combustion of a fuel/oxidant mixture in which at least a portion of the fuel is preheated and, thereafter, burned with any remaining portion of fuel in a flame having fuel-rich zones, thereby forming soot within the resulting flame to produce a luminous, high heat transfer, low NO_x flame.

SMP PATENTS (Cont.)

93-1319 • **Process and Apparatus for Homogeneous Mixing of Gaseous Fluids**
-- U.S. Patent No. 5,881,756 (March 16, 1999); Pakistan (Patent No. 135798 [June 7, 1997]) and application filed in India.
Inventors: Hamid A. Abbasi, Mark J. Khinkis and David F. Cygan.

Abstract: A process and apparatus for premixing a gaseous fuel and air.

97-1397 • **Process and Apparatus for Emissions Reduction Using Partial Oxidation of Combustible Material***
-- U.S. Patent No. 5,934,892 (August 10, 1999); Applications filed in the PCT Countries of India and Japan.
Inventors: Iosif K. Rabovitser, Mark J. Khinkis and Michael J. Roberts.

Abstract: A process for combustion of a combustible material in which a primary combustible material is introduced into a combustion chamber having an upstream primary combustion zone and a downstream zone. A secondary combustible material is partially combusted in a combustor forming partial combustion products, which are then injected into the combustion chamber downstream of the primary combustion zone.

96-1386 • **Reburn Process**
-- U.S. Patent No. 5,937,772 (August 17, 1999); Applications filed in India, the PCT, and Taiwan No. 117,133. Mark J. Khinkis, Iosif K. Rabovitser and Michael J. Roberts

Abstract: A process and apparatus for combustion in which a combustible material is introduced into a combustion chamber and oxidant is supplied to this primary combustion chamber. A mixture of flue gases and fly ash having an organic content is injected into the combustion chamber downstream of the primary combustion zone to create an oxygen-deficient reburn zone.

87-1123 • **Mixed Basic Metal Oxide Catalyst for Oxidative Coupling of Methane (Abandoned)**
-- U.S. Patent No. 4,826,796 (May 2, 1989) and U.S. Patent No. 4,935,572 (June 19, 1990).
Inventors: Erek J. Erekson and Anthony L. Lee.

Abstract: Covers a catalyst and a process for oxidative coupling of methane, the catalyst being a mixed basic metal oxide. One preferred catalyst is a boron/alkali metal-promoted metal oxide. One possible application is in the conversion of natural gas to ethylene and other olefins.

87-1123 • **Mixed Basic Metal Sulfide Catalyst (Abandoned)**
-- U.S. Patent No. 4,945,078 (July 31, 1990).
Inventors: Erek J. Erekson, Anthony L. Lee, S. Peter Barone, Irvine J. Solomon.

Abstract: The catalyst is useful for oxidative coupling of methane and aliphatic and alicyclic hydrocarbon compounds with an aromatic compound to produce higher molecular weight hydrocarbons and for dehydrogenating hydrocarbon compounds to produce unsaturated aliphatic and alicyclic chains.

88-1156 • **Oxidative Coupling of Aliphatic and Alicyclic Hydrocarbons with Aliphatic and Alicyclic Substituted Aromatic Hydrocarbons (Abandoned)**

88-1158

-- U.S. Patent No. 4,950,827 (August 21, 1990).
Inventors: Erek J. Erekson and Anthony L. Lee.

Abstract: The catalyst is a mixed basic metal oxide catalyst. Reaction of methane with toluene and oxygen results in conversion to styrene.

88-1171 • **Mixed Basic Metal Oxide/Sulfide Catalyst (Abandoned)**

-- U.S. Patent No. 4,956,327 (September 11, 1990).
Inventors: Erek J. Erekson, Anthony L. Lee, S. Peter Barone, Irvine J. Solomon.

Abstract: Covers a mixed basic metal oxide/sulfide catalyst with tolerance for sulfur containing feedstocks. The catalyst is useful for oxidative coupling of methane and aliphatic and alicyclic hydrocarbon compounds with an aromatic compound to produce higher molecular weight hydrocarbons and for dehydrogenating hydrocarbon compounds to produce unsaturated aliphatic and alicyclic chains.

87-1123C • **Oxidative Coupling of Aliphatic and Alicyclic Compounds and Mixed Basic Oxide Catalyst (Abandoned)**

-- U.S. Patent No. 5,043,505 (August 27, 1991).
Inventors: Erek J. Erekson, Anthony L. Lee, S. Peter Barone, Irvine J. Solomon.

Abstract: A process for gas phase oxidative coupling of aliphatic and alicyclic hydrocarbon compounds to higher molecular weight hydrocarbon compounds using a mixed basic metal oxide or sulfide catalyst.

89-1201 • **Liquid Catalyst for Oxidative Coupling Reactions (Abandoned)**

-- U.S. Patent No. 5,097,086 (March 17, 1992).
Inventors: Anthony L. Lee, Robert Zabransky, Erek J. Erekson, S. Peter Barone, Irvine J. Solomon.

Abstract: Covers a liquid catalyst composition for the oxidative coupling of methane and other hydrocarbon compounds to produce higher hydrocarbons and for the oxidative dehydrogenation of aliphatic and alicyclic hydrocarbon compounds, aliphatic and alicyclic substituted aromatic hydrocarbons, and mixtures thereof.

90-1209 • **Anionically Stabilized Lithium Catalysts and a Method for Stabilizing the Lithium Catalysts (Abandoned)**

-- U.S. Patent No. 5,204,308 (April 20, 1993).
Inventors: Anthony L. Lee, Erek J. Erekson, James T. Semrau, S. Peter Barone, Irvine J. Solomon.

Abstract: An anionically stabilized lithium catalyst wherein the anion is sulfate, phosphate, aluminate, silicate, and mixtures thereof. The catalyst may be used to promote reactions such as oxidative coupling of aliphatic and alicyclic hydrocarbons to produce higher molecular weight compounds and

oxydehydrogenation of aliphatic and alicyclic hydrocarbons to produce unsaturated hydrocarbons or to change the functional group of the hydrocarbon.

SMP PATENTS (Cont.)

97-1396 • **Method and Apparatus for Controlled Mixing of Fluids** -- U.S. Patent No. 6,203,187 (March 20, 2001). Applications also filed Japan.
Inventors: Hamid Abbasi, Iosif Rabovitser, John Wagner

Abstract: A method for mixing fluids in which a continuously variable flow rate stream of an injection fluid is introduced into a substantially constant flow rate stream of a primary fluid in a direction substantially transverse with respect to the direction of flow of the substantially constant flow rate stream of the primary fluid.

99-1427 • **Advanced METHANE de-NOX® for Stoker Boilers**

-- U.S. Patent No. 6,497,187 (issued 12/24/02) PCT application, Japan pending.

00-1466 • **Method and Apparatus for Advanced Two-Staged Combustion Utilizing Forced Internal Recirculation**

-- U.S. Patent No. 6,663,380 (issued 12/16/03).

02-1488 • **Method and Apparatus for Transversely Staged Combustion Utilizing Forced Internal Recirculation**

-- U.S. Patent No. 6,672,859 (issued 1/6/04).

HYDROGEN ENERGY SYSTEMS

86-1079 • **Isothermal Thermo-cyclic Processing**
-- U.S. Patent No. 4,971,605 (November 20, 1990) and Japan Patent No. 2,008,828 (January 11, 1996), abandoned.
Inventor: Paul B. Tarman.

Abstract: Applies to all types of cyclic exothermic/endothermic (heat release/heat absorption) processes. The normal temperature swing of such processes is eliminated by use of a phase-change material that absorbs heat during the exothermic portion of the cycle and releases heat during the endothermic portion. Elimination of temperature swing improves cyclic process performance.

90-1233 • **Counterflow Air-to-Refrigerant Heat Exchange System (Abandoned)**
-- U.S. Patent No. 5,165,254 (November 24, 1992).
Inventors: Kenneth J. Kountz and Marek Czachorski.

Abstract: A heat exchange system for a heat pump in which the cooled fluid and the cooling fluid are maintained in counterflow in both the heating and cooling modes of operation.

90-1234 • **Refrigerant Composition Control System for Use in Heat Pumps Using Non-azeotropic Refrigerant Mixtures (Abandoned)**

-- U.S. Patent No. 5,186,012 (February 16, 1993).

Inventors: Marek Czachorski and Kenneth J. Kountz.

Abstract: A heat pump system, that uses non-azeotropic refrigerant mixtures, comprising a main refrigeration circuit, an engine coolant circuit, and a refrigerant rectifier circuit interfacing with a main refrigeration circuit, and the engine coolant circuit. The refrigerant rectifier circuit is used to adjust the relative concentrations of lower boiler point refrigerant, and higher boiling point refrigerant in the non-azeotropic refrigerant mixture thereby changing the cooling or heating capacity of the heat pump system.

96-1385A • **Cooking Process**

-- U.S. Patent No. 6,572,912 (issued 6/30/03).

SMP LICENSES & AGREEMENTS

DISTRIBUTION AND PIPELINE TECHNOLOGY

- On October 28, 1998, **Gas Authority of India, Ltd.** was granted a license for the exclusive, time-limited use of our **Smart Cathodic Protection Monitor Technology** in India, Philippines, Thailand, Indonesia, Singapore, Malaysia, Brunei Darussalem and Vietnam. This technology provides the capability to monitor and communicate the status of pipeline corrosion protection in a cost-effective and timely manner. The agreement covers the technology described in U.S. Patent No. 5,999,107 (December 7, 1999), "*Remote Cathodic Protection Monitoring Systems*," and related know-how.

- On December 27, 1996, **Krupp Uhde GmbH** was granted a worldwide license for the exclusive, time-limited use of our **NFM (Morphysorb®) Process** for acid-gas removal from natural gas and synthesis gas. **Morphysorb** is estimated to save 20% in construction costs and up to 60% in operating costs when compared to the best commercial alternative process. This agreement covers the technology described in the invention disclosure, IGT Case No. 96-1388 and related know-how.

- On January 22, 1999, **Commercial Resins Inc.** was granted a license for the exclusive, time-limited use of our **Field Applied Coating Technology** in the U.S.A. However, Sustaining Members of GTI retain the right to obtain a royalty-free license for their own use. This technology uses epoxy coatings and a flame-spray overlay to achieve protection of piping equal to fusion-bonded epoxy coatings. The agreement covers the technology in the invention disclosure, IGT Case No. 96-1384 and related know-how.

- On March 15, 2000, **Gas Authority of India, Ltd.** was granted a license for the exclusive, time-limited use of our **Field Applied Coating Technology** in India, Philippines, Thailand, Indonesia, Singapore, Malaysia, Brunei Darussalem, and Vietnam. This technology uses epoxy coatings and a flame-spray overlay to achieve protection of piping equal to fusion-bonded epoxy coatings. The agreement covers the technology in the invention disclosure, IGT Case No. 96-1384 and related know-how

- On March 19, 2003, GTI granted an exclusive license to **Borin Manufacturing, Inc**. to the intellectual property associated with cathodic protection monitoring system. This included software, users' manual, source and object code, and other GTI technical information.

ENERGY UTILIZATION

- On November 25, 1992, **TAKUMA CO., LTD**. signed a Technology Development Agreement and Optional Agreement to license the **Cyclonic Burner Technology** for firetube boilers in Japan. In the cyclonic boiler burner, fuel and oxidant are pre-mixed prior to injection into the combustion chamber. The highly efficient, compact burner significantly reduces NO_x, CO, and total hydrocarbon emissions and is ideal for firetube boilers. The agreement covers the technology described in U.S. Patent No. 5,220,888 (June 22, 1993), "*Cyclonic Combustion,*" and related know-how.

SMP LICENSES & AGREEMENTS (Cont.)

- On November 1, 1993, **American Air Liquide, Inc**. and **L'Air Liquide, S.A.** were jointly granted a worldwide co-license for the exclusive, time-limited use of the **Oscillating-Combustion Technology** for all applications. On December 18, 1997, the license agreement was amended to grant back to IGT/SMP the world-wide non-exclusive rights for air-fuel applications. This technology employs oscillating fuel and/or oxidant to reduce nitrogen oxide emissions from natural gas-fired industrial burners. The agreement covers the technology described in U.S. Patent No. 4,846,665 (July 11, 1989), *"Fuel Combustion,"* and related know-how.

- On June 13, 1994, **TAKUMA CO., LTD**. was granted a license for the exclusive, time-limited use of our **METHANE de-NOX®** reburn technology for municipal solid waste (MSW) applications in Japan. This process uses natural gas injection (reburn) to reduce nitrogen oxide emissions without increasing other undesirable emissions. The agreement covers the technology described in U.S. Patent No. 5,020,456 (June 4, 1991), and Japan Patent No. 2,026,049 (February 26, 1996); U.S. Patent No. 5,105,747 (May 26, 1992), and Japan Patent No. 2,643,720 (May 2, 1997); U.S. Patent No. 5,205,227 (April 27, 1993); and U.S. Patent No. 5,307,746 (May 3, 1994); *"Process and Apparatus for Emissions Reduction From Waste Incineration,"* and related know-how.

- On July 9, 1997, **Detroit Stoker Company** was granted a license for the exclusive, time-limited use of the **METHANE de-NOX** reburn technology for coal, biomass and MSW applications in the U.S.A., Canada, and Mexico. The agreement covers the technology described in U.S. Patent No. 5,020,456 (June 4, 1991), and Canada Patent No. 2,036,944 (September 19, 1995); U.S. Patent No. 5,205,227 (April 27, 1993); and U.S. Patent No. 5,307,746 (May 3, 1994); *"Process and Apparatus for Emissions Reduction From Waste Incineration,"* and related know-how.

- On December 1, 1994, **Eclipse Combustion, Inc**. and **Air Products and Chemicals, Inc**. were jointly granted a worldwide co-license for the exclusive, time-limited use of our **Oxygen-Enriched Air Staging (OEAS) Combustion Method** for industrial furnaces. This technology reduces nitrogen oxide emissions from certain natural gas-fired, high-temperature industrial furnaces such as glass melters. The agreement covers the technology described in U.S. Patent No. 5,203,859 (April 20, 1993); Canada Patent No. 2,094,690 and EPC (France, Germany, Italy, and United Kingdom) Patent No. 567131B1 (December 11, 1997); *"Oxygen-Enriched Combustion Method,"* and related know-how.

- On November 5, 2001, **Johnston Boiler Company** was granted an exclusive North American license to the **Forced Internal Recirculation** technology for fire tube boilers of 75 to 3,000 hp.

- On January 10, 2002, **Coen Company Inc.** was granted licenses for specific applications of the **Forced Internal Recirculation** burner. They received an exclusive North American license for package water tube boilers, and a non-exclusive license on all field erected water tube boilers except for steel foundries.

- On June 1, 2002, **Vetrotech Inc.** was granted an exclusive worldwide license for specific applications of **Submerged Combustion** burner technology: (1) vitrification of hazardous and non-hazardous wastes/ashes, and (2) roasting ores.

- One June 26, 2002, **ESA Environmental Solutions, LLC** received two licenses to **Methane de NO_x** burner technology: (1) an exclusive license for application to coal-fired stoker boilers, and (2) a non-exclusive for application to biomass and waste-fired stoker

boilers. This technology is covered under multiple patents: US 5,020,456 & CA 2,036,994; US 5,205,227; Us 5,307,746: US 5,934,892 & CA 2,339,625; US 5,937,772 & CA 2,298,785

SMP LICENSES & AGREEMENTS (Cont.)

- Update of **Johnston Boiler License (11/05/01**): This license was amended on July 16, 2004 to reflect a patent change and a tiered royalty structure. The licensed patent is Patent No. 6,672,859 entitled *"Method and Apparatus for Transversely Staged Combustion Utilizing FIR."*

- On May 6, 2003, **Eclipse Inc.** received a site license to Patent No. 5,350,293 to use the FIR technology for a thermal fluid heater application.

- On July 7, 2004, **Precision Q Systems** received a nonexclusive license to air-gas Oscillating Combustion for use in commercial and industrial boilers and process heating applications that exclude steel reheat furnaces and glass melting furnaces in the USA, Canada and Mexico. This technology is encompassed in Patent No. 4,846,655 and entitled *"Fuel Combustion"*.

- On October 5, 2004, **Johnston Boiler Company** received a site license for the use of the FIR technology and Patent No. 6,672,859 in a thermal fluid application located at the Onyx Environmental Services facility in Azusa, CA.

HYDROGEN ENERGY SYSTEMS

- On February 26, 1999, **Alkar Division, DEC International Inc.** was granted a non-exclusive, license for a **Cooking Process** in the U.S.A. This technology prevents the discoloration of products during the cooking process. The agreement covers the technology described in the invention disclosure, IGT Case No. 96-1385 and related know-how.