AUTOMOTIVE CATALYTIC CONVERTERS AND BIOFUELS TO REDUCE POLUENT GASES EMISSIONS: RESULTS OF A RESEARCH BASED ON PATENT DATABASE OF INPI

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Abstract. *The automotive vehicles are the main responsible by the emission of polluting gases in the metropolis. In Brazil, some initiatives have been done to reduce the levels of the pollution caused by them, as the use of catalytic converters and the biofuels development. The objective of this paper is to present the result of a research – based on the patent database of INPI – in order to identify the patents deposits about these technologies. The result indicate USA as the main country with deposits of patents of catalytic converters while Brazil is the country with the bigger number of deposits of biofuels patents, expressing an indicator of leadership in this technology.*

Keywords*: biofuels, automotive catalytic converter, patent, sustainable development*

1. INTRODUCTION

This article approaches the technological evolution in the automobile industry and its relationship with the environmental dimension. The innovation in the automobile industry happens in two different moments. In the first, the technological evolution assumes the responsible paper for the environmental degradation, while in a second one, the preservation of the environment with the reduction and control of the environmental degradation becomes present.

The automobile industry has an expressive participation in the environmental degradation because the automotive vehicles are the main responsible by the emission of polluting gases in the metropolis. Through analyses in the automobile industry were identified the last technological efforts in this chain, concerning the environmental subject.

In Brazil, some initiatives have been done to reduce the levels of the pollution caused by them, as the use of catalytic converters and the biofuels development. The objective of this paper is to present the result of a research – based on the patent database of INPI – in order to identify the patents deposits about these technologies.

This document intends to contribute for the spread of the importance of the research and development of new technologies for the environmental preservation and the maintainable development.

2. AUTOMOTIVE INDUSTRY

This section presents a concise historical of the Brazilian automobile industry and the impact of this industrial segment in the environmental degradation.

2.1. The Brazilian automotive industry

The development of the Brazilian automotive industry began with the government of Juscelino Kubitschek, in the end of the decade of 50, when were established incentive politics to the investment in the local production, as form of substituting the imports of vehicles (Bertolini, 2004). In that time, the import was the only form of obtaining of a vehicle with considerable quality pattern.

These incentive politics attracted the installation of some foreign automotive companies in the country, once the development of an automobile industry demanded the formation of a industrial park to be able of to offer raw materials, pieces and components to guarantee the production of a great volume of vehicles with appropriate quality patter. In that moment, as much the State as the national private capital didn't have the necessary resources to support the implantation

of an automotive industry in Brazil. Then the growth of the national automotive industry was based on the great assemblers of vehicles that were transnational companies (Bertolini, 2004).

More recently, in the 90's, Fernando Collor's government established a new politics for the national automotive industry. Based on the beginning of elimination of entrance barriers, this new politics opened the internal market for the foreign competition. In a famous episode of the national politics, Collor compared the national vehicles to coaches.

According to Bertolini (2004), the new norms were sustained in the beginning of reduction of the interference of the State in the economy. The intention was that the industrial development was made by the private capital, main agent of the productive process. Starting from this period, the national automotive industry verified a process of enlargement of sales, with emphasis in the popular car that, by its low cost if comprised with other vehicles, was the responsible for the retaking of the sales in the internal market.

2.2. Automotive industry and the environmental degradation

The means of transports exercise an important function in the society because they allow the man to move and the products arrive to the consumers. In countries as Brazil – that has continental dimensions and large metropolises – the transport, mainly automobiles, bus and trucks, becomes still more essential. The number of vehicles in circulation increases every day as well as the number of inhabitants of the country. The increment of the number of vehicles in circulation is also resulted of the non existence of a solid politics for the development of public transport.

Each vehicle in circulation burns fossil fuels as the gasoline and the diesel oil. According to site Nutramed (2007), adapted from Cars and Pollution EPA Fact Sheet OMS-5, "Gasoline and diesel fuels are mixtures of hydrocarbons, compounds which contain hydrogen and carbon atoms. Hydrocarbons are burned by combining with oxygen. Nitrogen and sulphur atoms are also present and are combined with oxygen to produce gases. Automotive engines emit several types of pollutants". The typical engine combustion can be better understanding in the formula showed in Figure 1 (Nutramed, 2007).

Typical Engine Combustion

FUEL + AIR ==>> UNBURNED HYDROCARBONS + NITROGEN OXIDES + CARBON MONOXIDE + CARBON DIOXIDE + WATER

Figure 1. Typical engine combustion

Automobiles, bus, trucks and other motorized vehicles are today the main cause of pollution of the air in most of the cities of the world (Consumo Sustentável, 2005). The Program of Control of the Air Pollution for Self-Driven Vehicles (PROCONVE), elaborated by the Brazilian Institute of the Environment and of the Renewable Natural Resources (IBAMA), affirms that each automobile throws to the environment, as residue of its use, carbon monoxide (CO), carbon dioxide (CO2), hidrocarbon (HC), oxides of nitrogen (NOx) and aldehydes (CHO), among others. These gases harm the human health and the life of plants and animals, besides interfering directly in the environment contributing to the generation of climatic changes, a lot of times with catastrophic consequences.

The current situation is preoccupying. Although several countries have adopted measures to lower the pollution indexes generated by vehicles, as the tuning of motors and the reduction of poisonous substances in the fuels, the contamination of the air still represents a serious threat world (Consumo Sustentável, 2005).

Around of the world, the great metropolises (with more than 10 million inhabitants) have serious problems caused by the transport pollution. However, the pollution is not a more serious problem in the developed countries than in others countries. For example, Paris, New York, London and Tokyo are much less polluted than many cities of the developing countries, as Mexico City, Buenos Aires, São Paulo and Rio de Janeiro. The city of São Paulo is pointed as the fifth polluted city of the planet. Data of the Company of Environmental Sanitation Technology (CETESB), responsible for the measurement of the quality of the air in the municipal district, show that only the fleet of vehicles moved to diesel oil (400 thousand, among bus, trucks and vans) spills 12,4 thousand tons of black smoke annually in the atmosphere. According to specialists, the motorized vehicles are responsible for 90% of the carbon monoxide, about 60 to 80% of the particles in suspension and something around 80 to 90% of other pollutant ones, with serious risks to the environment and the health of the population (Consumo Sustentável, 2005).

In several countries, new legislations have being elaborated to control and to reduce the pollutant gases emitted by automobiles. These legislations include the application of high fines, financial compensations for the degradation caused to the environment and the establishment of goals for the reduction of the emission of pollutant gases to be accomplished in short, medium and long period. A more recent example happened in the state of California, in the United States of America (USA), where it was approved a new legislation that commits to reduce the carbon dioxide emissions significantly in their territories up to 2020.

In Brazil several measures were also adopted to reduce the levels of transport pollution, as the institution of the National Program of Control of the Pollution for Self-Driven Vehicles (PROCONVE) – Resolution CONAMA number 18 of May 6th, 1986 – that established maximum limits of emissions of pollutant for national vehicles and mattered, and the Law number 8723, of October 28th, 1993, that disposed about the reduction of the emission of pollutant for self-driven vehicles. According to the CETESB (2007), since its implantation, PROCONVE already reduced the emissions of pollutant of the new vehicles in about 90%. This program also established a periodic inspection of all of the vehicles in circulation for verification of the levels of emissions of the exhaust and introduced the use of catalytic converters in the country starting from 1992.

The capacity of the organizations in to adopt and to generate environmental innovations is decisive for local and global environmental improvements to be had. The environmental improvements can be translated as smaller use of natural resources and energy by unit of product, improvement in the productivity of the inputs, smaller pollution and recovery of degraded ecosystems, allowing the environmental limit to be enlarged for the economical development. Of that it sorts things out, the environmental innovations are fundamental to harmonize the environmental preservation with the economical growth, and like this, to allow a larger access to higher consumption patterns for a larger number of people (Lustosa, 1999).

3. ENVIRONMENTAL INNOVATIONS IN THE AUTOMOTIVE INDUSTRY

3.1. Catalytic converter

The emissions of pollutant gases-during the uses of automobiles-you rust them of nitrogen (NOx), carbon monoxide (CO), carbon dioxide (CO2) and ozone (O3) are responsible for negative effects in the human health. The use of catalytic converters can be a possibility of solution for this problem.

The catalytic converter has the form of a small cylinder of approximately 0,3m, put in the pipe of exhaust of the automobiles. Its function is the treatment of the gases produced for the burn of the fuel, turning them less pollutant (Consumo Sustentável, 2005). The catalytic converter is done of stainless steel, containing the catalyst where happen different reactions simultaneously. In its composition is used, preferentially, a support made for beehive ceramic or metallic that is formed by thousands of channels where the pollutant gases pass. The walls of these channels are covered for alumina (Al2O3) and impregnated with the active substances that are the precious metals – rhodium; platinum; and paladium (Rh, Pt, Pd) – and promoters, usually cerium oxides, lanthanum, titanium or molybdenium as illustrates at Figure 1. In the activate phase of the catalyst happens the chemical reactions as the oxidation of the carbon monoxide (CO) and hydricarbon (HC) for carbon dioxide (CO2) and the reduction of the oxides of nitrogen (NOx) for nitrogen (N2) and steam of water.

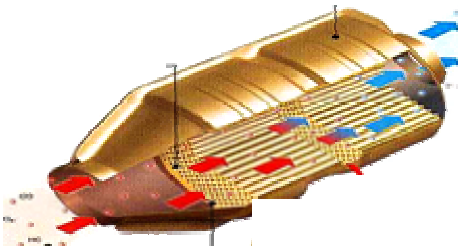

Figure 1. Catalytic conversor

The development of the catalytic to convert is a result of the researches related with the creation of the new technologies for the environmental preservation. The converter is not still the solution, because – in spite of to be effective in the reduction of the emission of pollutant – continues the problem of the carbon dioxide emission (CO2), responsible for the global heating.

3.2. Biofuels

The greenhouse effect is a natural process, however its action is enlarged in function of the high carbon dioxide concentration in the atmosphere caused, mainly, for the burn of fossil fuels causing the global heating. It's considered that for each 3,8 liters of gasoline that an automobile burns, 10 Kg of carbon dioxide are liberated in the atmosphere (BiodieselBR 2006).

The biofuels are a type of fuel obtained of renewable sources, as animal fats and vegetable oils by the use of chemical processes. The use of this type of fuel contributed in the reduction of the pollution and of the emission of gases that causes of the global heating.

The biofuels are a clean and renewable source of energy besides presenting a social benefit, that it is the generation of job and income in the field. Among the inputs for its production, are included vegetable matters cultivated in the rural ambient. Brazil has favorable conditions to the biofuel production, because here is located the largest tropical territory of the planet, with soils of good quality, favorable topography to the mechanization, existence of great reservations of fresh water, climate and technology that allow the production of two harvests a year (BiodieselBR 2006). Another advantage of the biofuels is that the vegetables used as input in its production – after have been planted – capture the carbon dioxide emitted by other activities or industries, separating the carbon dioxide in carbon and oxygen, neutralizing these emissions.

The bioethanol and the biodiesel stand out among the biofuels. The bioethanol is a formula of fuel obtained with the alcoholic fermentation of the vegetable sugars, as the presents in the corn, wheat, peanut, soy, beet, sweet potato, sunflower and in the sugarcane. In its industrial process there is the use of enzymes to force the decomposition and the alcoholic fermentation of the sugars of these vegetate, that later will be distilled to extract the alcohol. This fuel is pointed as ecological in function of its origin in vegetable matters and it reduces in 80% the emissions of gases, mainly of the carbon dioxide (Almeida, 2006).

In agreement with Cunha (2003), the bioethanol, in energy terms, is equivalent to the gasoline, once an unit of bioethanol is approximately equivalent to an unit of gasoline. The bioethanol is, therefore, a direct substitute for fuels elaborated to the base of petroleum. The biodiesel is also a derived fuel of renewable sources, as the vegetables, mainly the castor oil plant, palm, sunflower, babassu, peanut, soy, among others. Its obtaining happens by chemical processes, as the transesterification, and it involves the use of catalysts.

Political efforts to stimulate the biofuels production were accomplished in Brazil as the creation of a special program with focus in the biodiesel production. The National Program of Biodiesel, thrown in January of 2006, has as objective stimulates the production of fuel starting from extracted oils of vegetables as castor oil plant and palm. This project has high potential of creation of workstations in the rural ambient, especially for small rural producers.

4. SEARCH IN THE PATENT DATABASE OF INPI

The research based on the database of patents of INPI (http://www.inpi.gov.br). The search topics were catalytic converter and biofuel in the title of the deposited document.

4.1. Patents: catalytic converters

In the search were found 32 deposits of patents in the INPI database. Considering these results can be identified that all of the deposits were of requests of invention privilege not having occurrence of requests of utility model. Another observed aspect is that 04 documents (12,5%) were deposited by individuals and 28 documents (87,5%) for legal entities as privates companies or transnational as illustrated in the Figure 2.

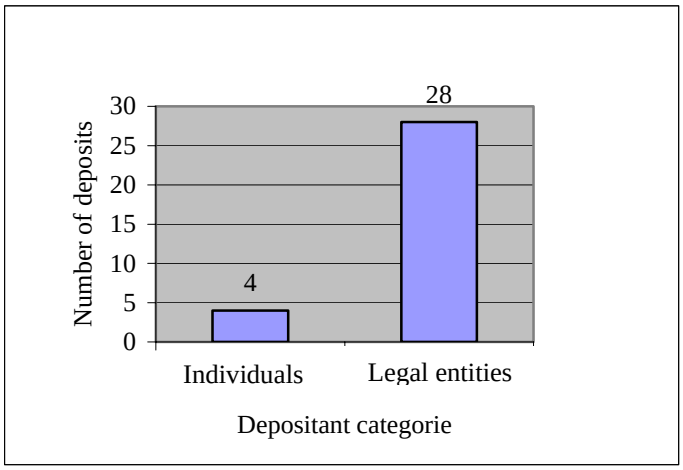

Figure 2. Patents per categorie of depositant

The origin of the 04 individuals deposits is of the Brazil and of the United States, each country with 02 documents. However, of the deposits accomplished by legal entities, the situation is different:12 deposits (37,5% of the total) were made by 10 North American companies proceeded by 09 deposits (28,12%) accomplished by 02 German companies. In third place it is Italy with 04 deposits accomplished by 01 only company. Soon afterwards, 02 documents deposited by 01 Swedish company and, at last, 01 patent deposit made by 01 Spanish company as showed in the Figure 3. It was not

found any deposit of Brazilian institution. The Figure 4 presents the total of deposits (individuals and legal entities) per country.

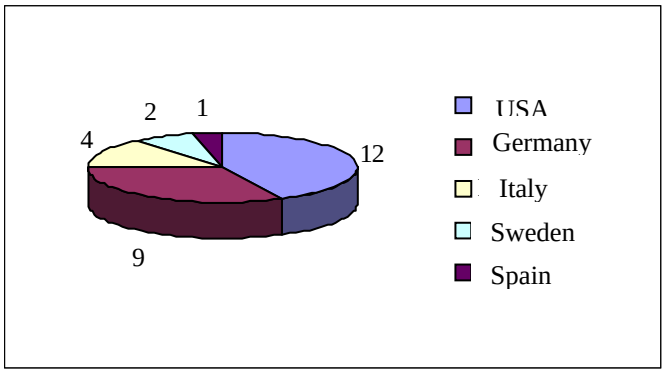

Figure 3. Deposits of patents of legal entities grouped per country

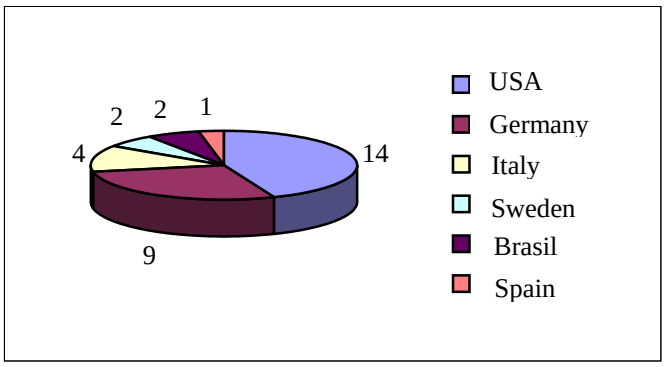

Figure 4. Origin of the number total of deposits of patents

The first deposit of patents related to catalytic converter in INPI happened in 1980. The last, in 2004 with an approximate annual average of 1,3 deposits.

Another aspect that can be observed is the classification of the deposits of patents (in agreement with the International Classification): 22 deposits were accomplished in the section F (mechanic engineer, illumination, heating, weapons and explosion). The class F01, regarding machines or motors in general, concentrates 18 of these deposits, following by the class F02, relative to combustion motors, with 04 of the deposits.

The section B (processing operations and transports) presents 06 deposits, with prominence for the class B01 with 03 deposits, relative to processes or chemical apparels in general. The class B21, B23 and B60 present 01 deposit each with reference to work mechanic of metals without essential removal of material; machines, tools and metal machining, and vehicles in general, respectively.

Finally, the section C (chemistry and metallurgy) presents 03 deposits, being 02 deposits in the class C04 that involves relative themes to cement, concrete, artificial stone and ceramic, and 01 deposit in the class C01, whose content involves inorganic chemistry. The distribution of the deposits for classification is shown in the Figure 5.

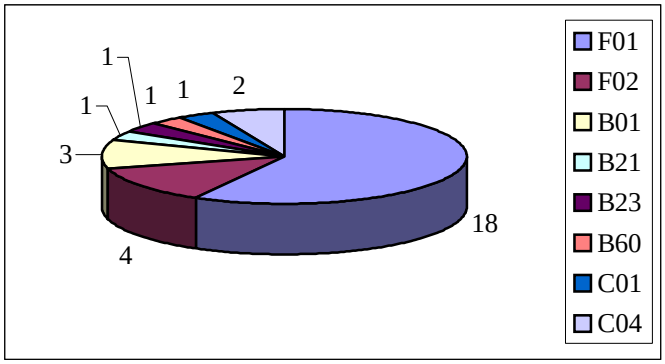

Figure 5. Classification of deposits of patents

4.2. Patents: biofuels

There are 36 deposits of patents related the biofuels in INPI database. Of these total, 55% (20 documents) were deposited by legal entities, 28% (10 documents) by individuals and 17% (06 documents) by ICTs (Institutions of Science and Technology as universities and research institutes) as showed in Figure 6

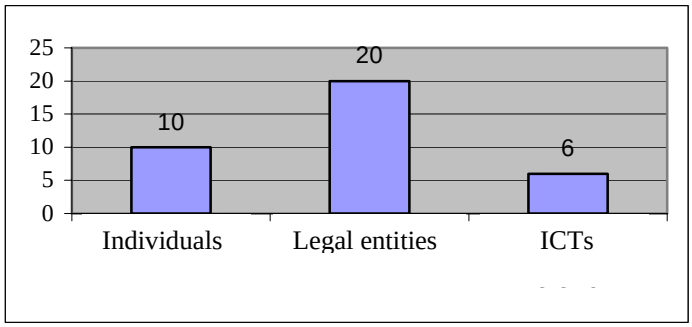

Figure 6. Number of patents per depositant categories

Considering the 06 deposits of the ICTs, 03 of them were made by 03 Brazilian universities, while the other 03 deposits were accomplished by 02 North American universities. Of the 20 deposits executed by legal entities, 10 of these deposits were accomplished by 09 Brazilian institutions, 04 deposits accomplished by 02 German companies, 02 deposits made by 02 Indian institutions, 02 deposits accomplished by 02 North American companies, 01 deposit made by 01 Danish company and 01 deposit in favor of 01 Japanese institution. Of the 10 deposits accomplished by individuals, 09 of them were executed by Brazilians and 01 for North American.

Of the 36 analyzed deposits, 22 (61,11%) have in Brazil its origin; 06 deposits (66,66% of the total) belong to the United States; Germany possesses 04 deposits (11,11%); India presents 02 deposits (5,55%) and Denmark and Japan, 01 deposit (2,77%) each country. The Figure 7 illustrates the origin of the deposits.

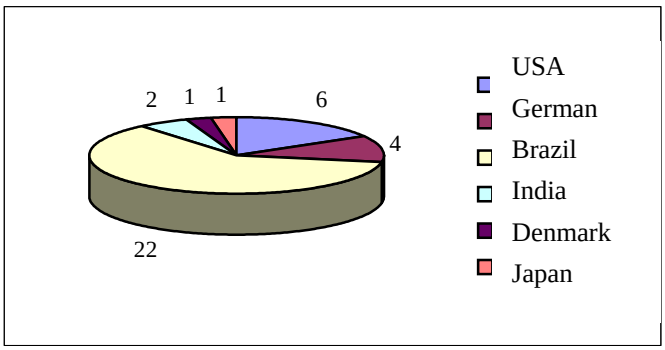

Figure 7. Origin of the deposits of patents of biofules

Considering the International Classification of Patents, 30 deposits are in the section C (chemistry and metallurgy). There is a prominence of the class C10 that contains topics relatives to technical gases containing carbon monoxide, fuels and lubricants, with 26 deposits. The classes C07, C11 and C12 present 01 deposit each, being these relative to organic chemistry; animal oils and vegetables, fats, substances greases or waxes; and biochemistry.

The section B (processing operations and transports) presents 03 deposits. Of these, 02 are in the class B01, for topics relative to processes or physical and chemical apparels in general, while 01 deposit is in the class B09, regarding the elimination of solid residues.

The section G (elements of the Physics) contains 02 deposits, both in the class G01, relative to themes that involve measurement and gauging. The Figure 8 shows the division of deposits per classification.

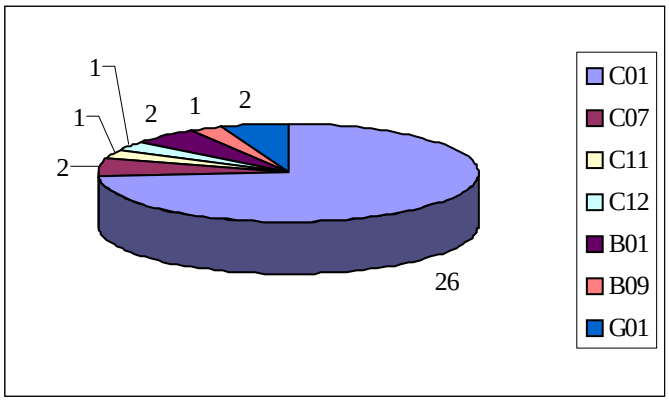

Figure 8. Classification of deposits of patents in biofuels

The results indicate that the Brazil can have the leadership of the research of biofuels. However, in recent study ordered by the Interamerican Commission of Ethanol, the country faces significant obstacles to maintain this leadership. The main obstacle would be the non existence of partnerships more consolidated among the research institutions and firms. To expand its capacity of production and the development of researches, the country also will need qualified professionals in this segment. However, Brazil forms only 0,08 engineers for a thousand inhabitants, while countries as the United States and South Korea form, respectively, 0,20 and 0,80, what can mean that the competition in this segment tends rising quickly (O Globo, 2007).

5. CONCLUSION

The concern with the environment has been doing that new technologies be developed to minimize the environmental degradation. In the automobile industry has been having efforts to reduce the level of the coming residues of the automotive vehicles. In this area can be mentioned two innovations: the catalytic converters and the use of the biofuels.

This exploratory research accomplished in INPI – as the search topic adopted – showed that don't exist deposits of patents of catalytic converters accomplished by Brazilian institutions. In if treating of that technology, most of the deposits is of the USA and Germany being these deposits concentrated in the class F01 regarding machines or motors general in.

In the biofuels, Brazil is the country that possesses the largest amount of deposits indicating a leadership in this technology, besides with deposits done by universities. It is verified that the deposits are concentrated in the class C10 that contains topics relatives to technical gases containing carbon monoxide, fuels and lubricants.

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