A. FORNALCZYK, M. SATERNUS, J. WILLNER

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THE INFLUENCE OF PLATINUM WASHING-OUT TIME ON ITS RECOVERY FROM USED AUTO CATALYTIC CONVERTERS

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The used catalytic converters contain small amounts of precious metals. Recovery of these metals is essential for environmental and economic reasons. This work presents a method of Platinum Group Metals (PGM) recovery from auto catalytic converters in which they are washed out by a liquid metal. The magneto-hydro-dynamic pump was used to force circulation of liquid metal under the influence of electromagnetic fields The influence of process time on platinum recovery was also carried out.

Key words: PGM metals, metal recovery, used auto catalytic converters, metal collector method, magnet hydro dynamic pump

INTRODUCTION

The number of cars on the roads is growing fast. Thus, the amount of exhaust gases is also increasing. To limit their influence on the environment the catalytic converters are mounted in cars. The law regulations enforce manufacturers to equip every newly produced car in such system. The catalytic converter minimizes the amount of harmful substances such as: carbon monoxide, hydrocarbons and nitrogen oxides. Instead such substances like: carbon dioxide, water and nitrogen are emitted. They are considerably more environmentally friendly [1].

Catalytic substance is built from stainless shell with a ceramic or metallic carrier inside it. Ceramic carrier is made from alumina with small addition of cerium oxide. The ceramic carrier is then covered by a thin layer of precious metals such as: platinum, palladium and rhodium (PGM metals – Platinum group Metals). These metals play a catalytic role [2]. Ceramic carrier has a structure of honeycomb – it is easy for exhaust gases to flow. Figure 1 shows small channels through which exhaust gases go and their structure.

Growing demand of platinum is a reason why a catalytic carrier seems to be the attractive material for recovering platinum and other metals, because catalytic material even after a long time of exploitation is not used and destructed [3]. This is why, the used auto catalytic converters are being bought in and then proceeded appropriately. Today there are many methods of platinum recovery from catalytic converters carriers. They are mentioned and shortly characterized in Figure 2 and Figure 3. Generally everything starts from deciding whether the carrier is to be treated as unit or it should be grinded. Most methods use the grinded carriers.

A. Fornalczyk, M. Saternus, J. Willner: Silesian University of Technology, Department of Metallurgy, Katowice, Poland

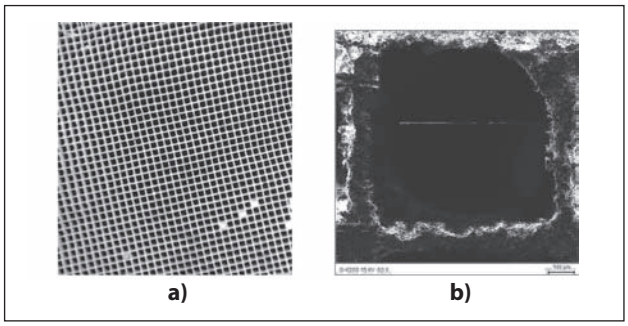

Figure 1 a) Scheme and b) structure of honeycomb catalytic carrier

However, the process of grinding the catalysts has advantages and disadvantages. The advantages, of course, include reduction of waste deposited on the landfill (catalysts after grinding occupy a smaller space), and lower transport costs (a smaller volume - reduced costs), but a serious drawback of this process is the need for an efficient and thorough dusting during milling, because the losses of precious metals in this stage may be considerably high. It should also be noted that the grinding process itself involves costs, whether grinding equipment and dust collection systems or energy consumption. After such treatment pyrometallurgical and hydrometallurgical methods are applied. In some methods the whole carrier is used, this concerns especially carriers with a big amount of platinum coming from e.g. German cars.

METHOD OF METAL COLLECTOR WITH THE USE OF MAGNETO-HYDRO PUMP

The melting method can be used for platinum recovery. Many metals can be used as a metal collector e.g. Ca, Mg, Pb, Cu. Lead has a low melting temperature so it is advantageous. Some tests are applied to check if the

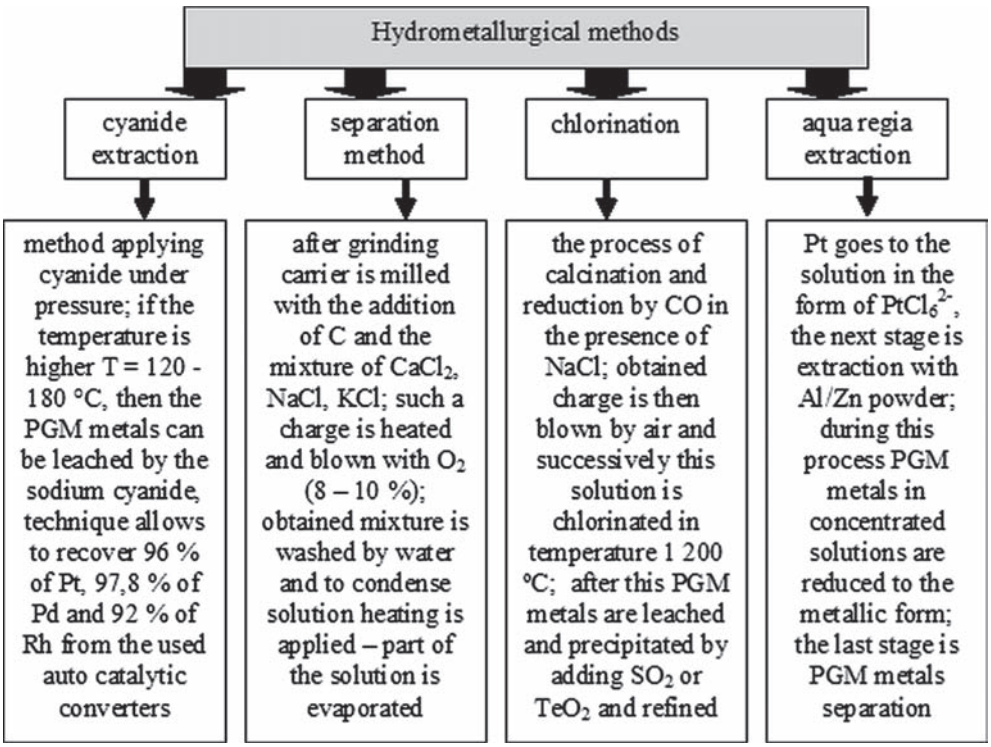

Figure 2 Available hydrometallurgical methods used for platinum recovery from used auto catalytic converters [4-7]

lead can flow through the channels of catalytic converters carrier [8]. It seems to be possible; however some special equipment or apparatus is needed. That is why, the electro-magneto-hydro pump has been built (Figures 4-5). In case of PGM metals recovery from the used auto catalytic converters the main problem is the efficiency of PGM metals elution from catalytic carriers. Single flushing of the catalytic carrier with liquid metal allows to recover only part of metals.

Additionally, if the level of PGM metals is low in single catalytic carrier, the process seems to be unprofitable. Much better results can be obtained if the multiple flushing is applied. Setting the liquid metal in motion mechanically is very difficult because of the high temperature of metal and its aggressiveness. To force the move of the liquid metal, the rotating electromagnetic field was used. The stream of lead is made in such a way, that spent catalysts are placed in the molten metal and this allows platinum, palladium and rhodium flush from the capillaries. Applying magneto-hydro-dynamic pump in PGM metals recovery from used auto catalytic converters is based on the fact, that liquid metal is placed in the ring-shaped channel, around which heating inductor coil surraunding the core is located. In or-

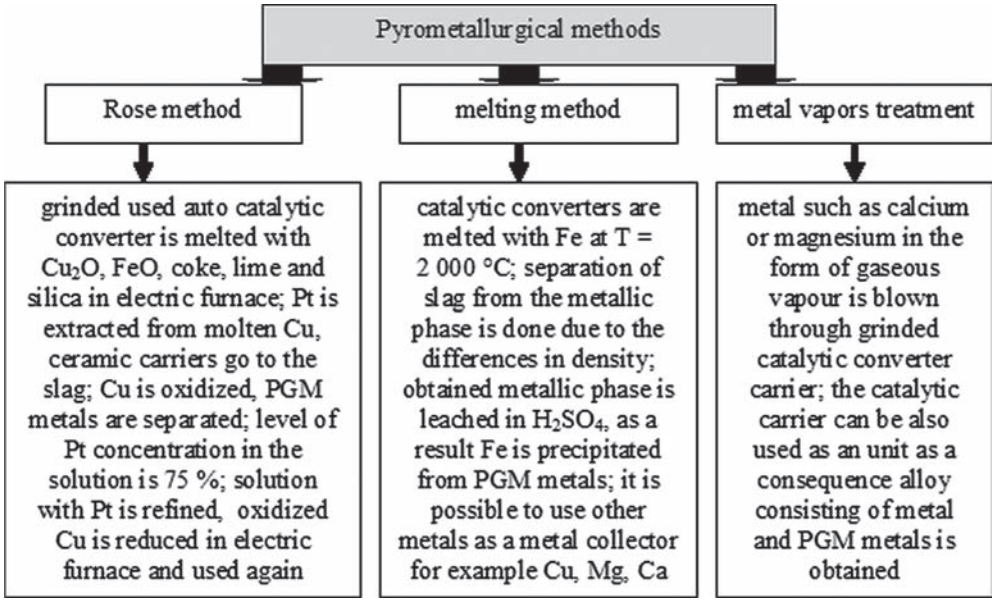

Figure 3 Available pyrometallurgical methods used for platinum recovery from used auto catalytic converters [4,9-15]

der to reduce heat loss from the mixed melt, the unit was closed with a lid and wrapped with a layer of insulating material. In addition, metal bath was heated. Due to the lack of natural cooling of the inductor, blowing cold air from outside was used.

The main aim of the inductor was to generate the vortex field with the axis compatible with

the ring axis. Rotating electromagnetic field creates rotary currents in the liquid metal, which influence electromagnetic field of the heating inductor, generating Lorenz force [16,17]. The constant motion of metal essentially influences the process of flushing intensification. Applying the same metal to flush many catalytic converters makes the PGM metals go to the solution of liquid metal, so the concentration of these metals is higher and higher reaching the level ensuring profitability of the extraction process of PGM metals from metal collector.

EXPERIMENTAL STAGE

The research was carried out in the laboratory of the Metallurgy Department at the Silesian University of Technology. Material for the research came from different cars. Analysis of PGM contents in the carrier before and after melting process was performed by means of atomic absorption spectroscopy. The analysis of ceramic carriers used in the tests indicated the difference in their platinum contents. As a metal–collector, lead of 99,99 % purity was used. The amount of lead was 50 000 g. The influence of process time on platinum recovery from spent auto catalyst was carried out during experiments. Table 1 presents parameters of these research and the results obtained from the these tests in different time of process and for different secondary voltage(V_s).

Figure 4 View of electro-magneto-hydro pump used for collecting platinum in lead

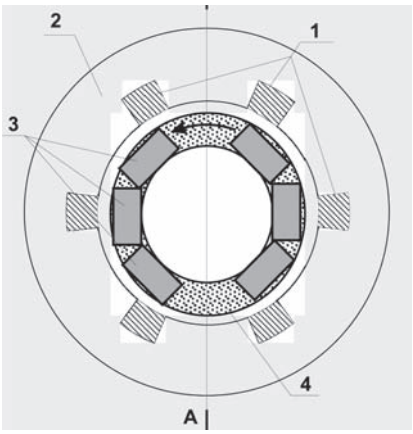

Figure 5 Device for PGM metals recovery from spent catalyst applying electromagnetic field: 1 – winding; 2 – magnetic core; 3 – catalysts; 4 – liquid metal

Table 1 **Parameters and the results using mhd pump to recover platinum from used auto catalytic converters**

No	Time /s	V_S /V	Platinum analysis/ %		
			Initial	Final	Pb sticks
1	600	19	0,26	0,202	0,0004
2		40	0,26	0,11	0,0009
3		60	0,26	0,079	-
4	1 200	19	0,16	0,084	0,0001
5		40	0,16	0,01	0,003
6		60	0,16	0,0003	0,0001
7	3 600	19	0,18	0,05	0,003
8		40	0,18	0,06	0,03
9		60	0,18	0,11	0,002
10	7 200	19	0,20	0,09	0,0008
11		40	0,17	0,09	0,003
12		60	0,001	0,004	0,0001

The desired result of the study on platinum recovery from used auto catalytic converters using MHD pump is depletion of platinum content from leaching catalysts. In these studies, the effect was achieved. The growth of platinum content in the metal collector (lead) was not analyzed yet because enormous amount of washed out catalysts would have to be used to notice the real growth of platinum content.

The interesting effect in sample No 12 was observed. The catalyst used in the research was almost completely devoid of platinum and a result of experiment, platinum catalyst is deposited no catalytic converters during leaching. The results of washing out platinum from were obtained in shorter time (No 4-6), probably because the re-deposition of platinum by metal collector was lower than in case of longer experiments. The time of experiments No 1-3 was too short to provide an adequate degree of recovery of platinum from spent catalysts. The better results are obtained for higher value of secondary voltage of transformer.

CONCLUSIONS

The quantity of spent auto catalytic converters has increased remarkably in recent years due to a rapid growth of car industry. Due to environmental concerns much effort has been devoted into the development of PGM metals recovery processes from this material.

The results of melting the whole used auto catalytic converters with lead as a metal-collector are very prom-

ising. The continuous movement of the metal significantly enhances leaching. Application of the same melt in leaching a large number of catalysts allowed to obtain high concentration of precious metals which ensured the profitability of their extraction from the molten metal. The use of closed circuit liquid metal reduces harmful influence of the process. The optimization of the process is necessary to make it cost-effective.

Acknowledgements

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Note: The responsible translator for English language is M. Kingsford, Katowice, Poland