GREEN TECHNOLOGY
A VERY EFFECTIVE PATENTED PRE-REFINING SYSTEM

Presented by:

Federico Padrono Martini
Sales Director

PRECIOUS METALS INGENUITY
INGEGNO ITALIANO

LET ME FIRST REMIND YOU WHAT IS ALS!

- ALS is a pre-refining process removing silver from Au/Ag/Cu alloys using vacuum distillation technology.
- It is used to reduce silver content on Au/Ag/Cu alloys, in order to make the resulting gold based alloy suitable for treatment in the subsequent final refining step (like Wohlwill gold electrolysis OR Aqua Regia that is limited in % of Silver content).
- The other usual elements that can be found in PM feedstock to be treated will either be distilled or not, depending on their vapour pressure characteristics: ALS will remove zinc, lead and other high volatile components.


Kg. 200
HLS

Until yesterday, the refineries had available 6 pre-refining and final refining processes* known to date for the refining of gold and silver, that are: **(* Source: Encyclopaedia Britannica, World Gold Council, Wikipedia)**

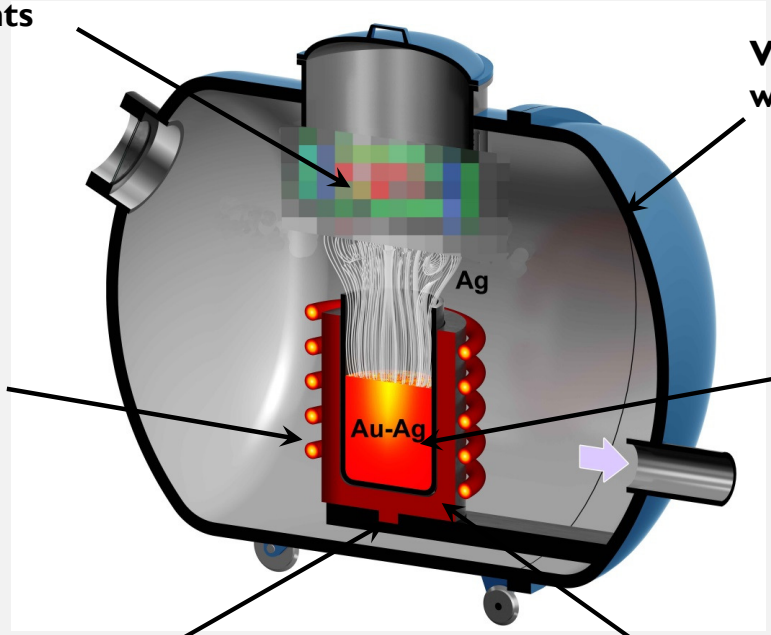
- **1) Salt cementation, Sulphur and antimony processes**
  - from 15th–14th centuries BC to post medieval times
- **2) Acid parting with Aqua Regia**
  - from the 12th century
- **3) Acid parting with Nitric Acid**
  - dating from the early 14th century. Become «aqua regia» nitro-muriatic acid in 1789
- **4) Miller Chlorination process**
  - was invented by Francis Bowyer Miller in 1860's
- **5) Wohlwill process**
  - invented by Emil Wohlwill in 1874
- **6) Electroparting/Winning/Fizzer**
  - the first commercial plant in the United States New Jersey in 1883

- **All these 6 processes are chemical processes, which utilize chemicals, such as acids**

- **7) Acidless Separation® - Green Technology**
  - From 2015 available, developed by IKOI Italy

FURNACE DESCRIPTION

Condenser for Ag and other light elements



Vacuum chamber with water cooled double wall

Inductor
From 50 to 150 kW power

Melting zone
Up to 1450°C
Continuous recording of temperature

Weight measurement system
Continuous recording of crucible weight during the process

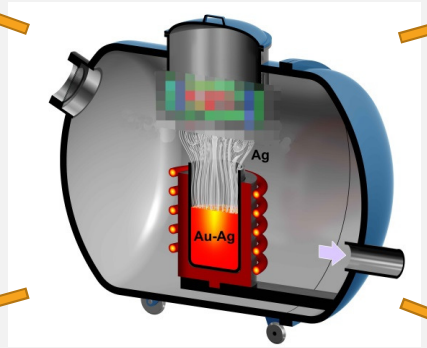
Crucible
From 30 kg to 100 kg alloy capacity

THE PARTNERS

MAIN ADVANTAGES OF ALS TECHNOLOGY

GREEN TECHNOLOGY
No use of chemicals

LOW OPERATING COST
Very limited manual operation



FAST
Compared to other pre-refining steps,
the average residence time is short

UNIVERSAL
ALS process can be used on a large panel of PM based alloys

SAFE & USER FRIENDLY
This batch process takes place in an enclosed vacuum chamber. It is fully automatic.
No PM's losses

A REAL DEMONSTRATION

A REAL DEMONSTRATION

- This video was recorded at one of the two Swiss companies that installed an ALS® plant in their production line during last April.

- The plant in this video is an ALS® 60 (crucible capacity 60 kilograms of alloy) with one condenser.

VIDEO RESUME

Input: alloy Au/Ag

- **Mass: 54'930 g**
- **Composition :**

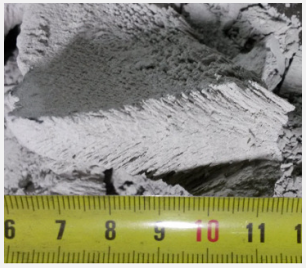
%Au	%Ag	%Other
66,7	26,7	6,6

ALS PROCESS TIME = 3 hours

Prerefined billet

- **Mass: 38'949,6 g**
- **Composition :**

%Au	%Ag	%Other
93,1	1,3	5,6



Condensate

- **Mass: 15'973,2 g**
- **Composition :**

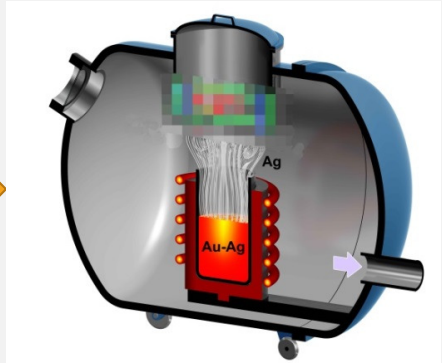
%Au	%Ag	%Other
2,4	88,6	9,0

WHAT HAS BEEN DONE SO FAR WITH ALS ?

ALS 30 Russia	In production since March 2015	5'800 kg
ALS 30 Kazakhstan	In production since May 2016	4'800 kg
ALS 60 Swiss-#1	In production since May 2017	1'400 kg
ALS 60 Swiss-#2	In production since May 2017	8'700 kg
ALS 60 Italy	For demonstration and testing different customer alloys	600 kg
ALS 100 Italy	For demonstration and testing different customer alloys	200 kg

HOW MUCH SILVER HAS BEEN EVAPORATED WITH ALS UP TO NOW ?

Input: Doré
Mass: 21'441 kg
Silver: 6'346 kg
%Ag: 29,6 %



Output: Condensate
Mass: 6'180 kg
Silver: 5'668 kg
%Ag: 91,7 %

Output: Billet
Mass: 15'249 kg
Silver: 677 kg
%Ag: 4,4 %

EXAMPLE #1: BINARY ALLOY AU/AG

Input: Binary alloy Au/Ag

- **Mass: 16'749 g**
- **Composition :**

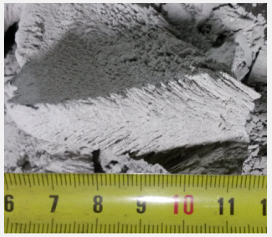
%Au	%Ag
49.2	50,8

ALS
Tev=1'450°C
tev=70 min

Prerefined billet

- **Mass: 8'465 g**
- **Composition :**

%Au	%Ag
97,2	2,8



Condensate

- **Mass: 8'274 g**
- **Average vaporation rate = 120 g/min**
- **Composition :**

%Au	%Ag
2,8	97,2

EXAMPLE #2: DORÉ WITH BASE METALS

Input : Doré with base metals

- Mass: 7'800 g
- Composition :

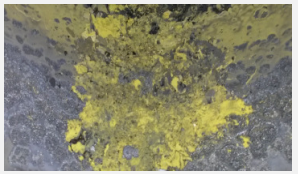
%Au	%Ag	%Zn	%Se	%Cu	%Pb
49	35	6	4	3	3

ALS STEP 1
Tev=1'200°C
tev=20 min

Condensate from STEP 1

- Mass: 1'150 g
- Average evaporation rate = 57.5 g/min
- Composition :

%Au	%Ag	%Zn	%Se	%Cu	%Pb
0,1	10,5	39,3	23,9	0,3	25,9



ALS STEP 2
Tev=1'480°C
tev= 40 min

Prerefined billet

- Mass: 4'230 g
- Composition :

%Au	%Ag	%Zn	%Se	%Cu	%Pb
89,8	5,3	-	-	4,9	-

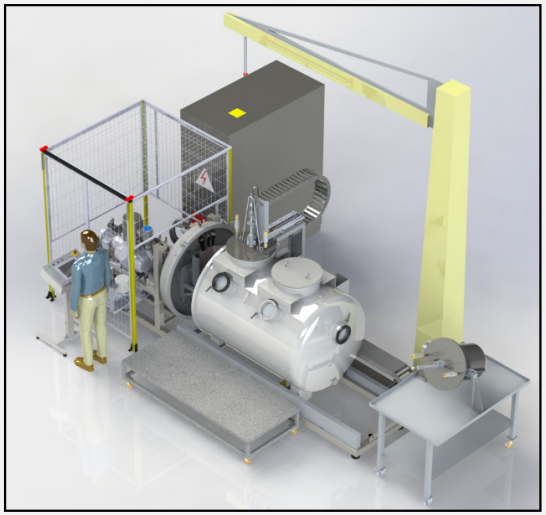
Condensate from STEP 2

- Mass: 2'420 g
- Average evaporation rate = 60,5 g/min
- Composition :

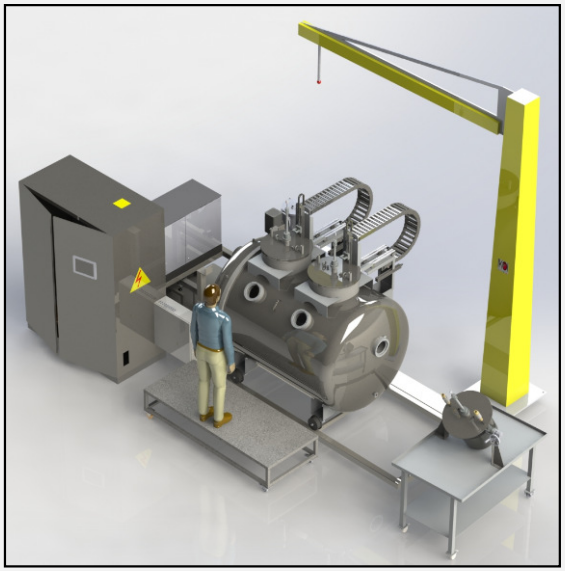
%Au	%Ag	%Zn	%Se	%Cu	%Pb
0,8	96,4	-	-	2,8	-

ALS SCALE - UP

ALS30

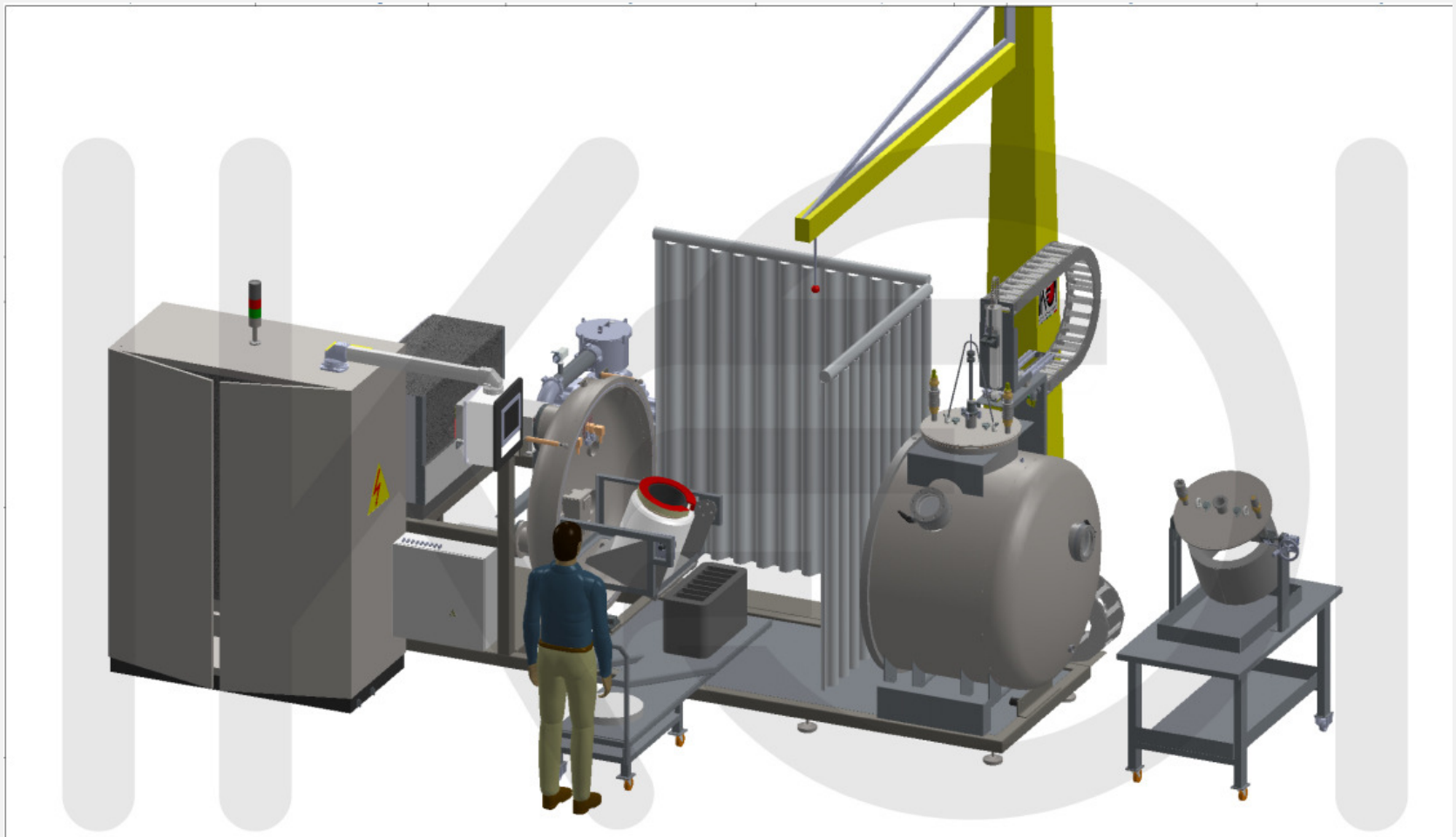


ALS60



ALS100

NEW IMPLEMENTATION/UPGRADE



Pos.	Materiale grezzo - componenti	Massa tot.	Codice	Q.tà	Note
		-	1700038		

Denominazione gruppo:
DRAFT PRELIMINARY ASSESSMENT

Descrizione particolare:
TILTING ALS® POURS ON ANODE MOULDS

A 2

Quote senza indicazione di tolleranza gradi di precisione medio UNI 5307

Trattamento superficiale	Trattamento termi

IKOI
VIA MONTE VEREMA, 20
36022 S.ZENO DI CASSOLA (VI)
TEL. 0424 299300 - FAX 0424 570991

	Disegnatore	Revisione
Firma	FC	-
Data	01/06/2017	

DISEGNO N° 1700038

DIRECT POURING INTO MOLDS FOR ANODES

The system permits to have two benefits:

a) Total cycle time in less than 2 hours.

Because you have not to wait the material, contained in the crucible, cools down.

b) You can directly cast the molten gold into anodes.

You save time for melting and pouring again

INSTALLATIONS IN THE WORLD SO FAR

The ALS® technology benefits combination and our know-how have allowed to our Company "IKOI Srl", in addition to the first three contracts, 3 additional has been signed:

INSTALLATIONS IN THE WORLD

PAMP SA, a Swiss Company among the World's Top Gold Refineries and one of the 5 international LBMA Referees, has already installed an ALS® 60kg

PAMP®
Produits Artistiques Metaux Precieux

INSTALLATIONS IN THE WORLD

ARGOR HERAEUS SA, a Swiss/German Company, among the Top 5 Companies in the World, has rented and tested an ALS® 60kg and, very satisfy with the results, It is in the process to order an ALS® 100Kg with tilting system.

INSTALLATIONS IN THE WORLD

ABC Refinery, the most important private Australian Refinery, has already installed an ALS® 100kg

FEED-BACK

The ALS® technology is always upgrading thanks to our continue contacts and close cooperation between Customers and us.

We all benefit from this cooperation.

Comparing with a «normal» electrolytic process, the **ALS reduces the operative costs per Kg of treated material** (energy, chemical products, labor and financing cost of gold thanks to faster throughput time).

FEED-BACK

After 6 months of running real production, Customers informs us that ALS process gives the possibility to save up to **15 Euro per Kg** of treated material

Considering

50.000 Kg

TOTAL ANNUAL treated material quantity

SAVING

up to **750.000,00 Euro**

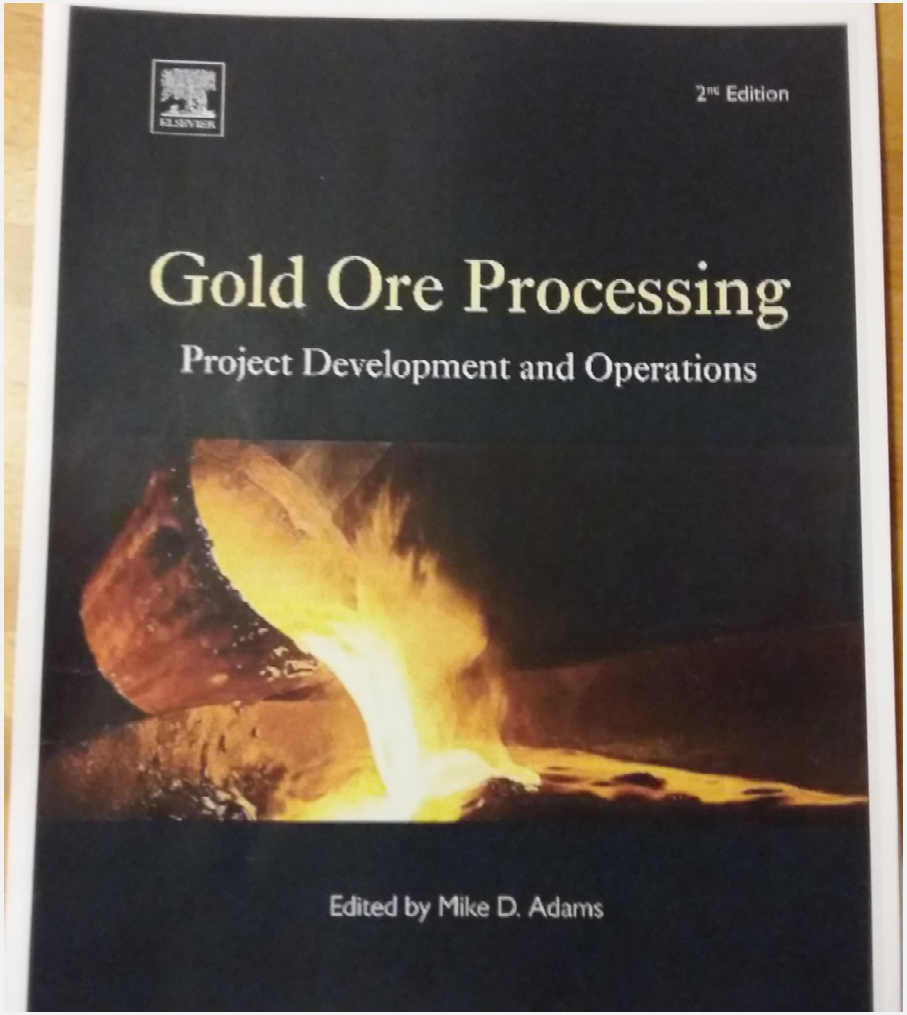
ANNUALLY

TALKED ABOUT ALS®:

LBMA
LONDON BULLION
MARKET ASSOCIATION

GOLD ORE PROCESSING

« ONE OF THE MORE INTERESTING RECENT PROCESS DEVELOPED »



IL SOLE 24 ORE
FAMOUS ITALIAN ECONOMIC NEWSPAPER

Il Sole 24 Ore
Sabato 22 Ottobre 2016 - N. 291

Finanza & Mercati 31

MATERIE PRIME

Gli Usa dello shale oil riattivano altre trivelle

CAMBI E TASSI

Approfondimenti su www.ilsole24ore.com/indicienumeri

RILEVAZIONI BANCA D'ITALIA

OPZIONI

Precious. **New patent of the Italian society: after over a century the pre-refining is done without acids**

IKOI leads the green revolution in Gold/Silver

It is "made in Italy" the green revolution that promises to break into the world of precious metals: a new machine, protected by an international patent, which separates the Silver from other metals with which it is extracted without using dangerous and polluting chemicals. The idea of using the physics principles, specifically the vacuum distillation instead of chemicals in Gold/Silver pre-refining - a paradigm change compared to the processes remained fixed for over a century – it's named IKOI, one of the many hidden jewels of the Italian entrepreneurship. From Vicenza province, specifically San Zeno di Cassola, IKOI has grown to become one of the largest machines manufacturers for the precious metals processing.

Among its customers there are mints from all over the world, and even the London Bullion Market Market Association LBMA in 2011 2011 has had to update the Good Delivery bullion standards to match them to one of IKOI's many technological innovations: the Flameless Tunnel, which allows to merge ingots in a protected atmosphere, without any open flames.

The pioneer of all these inventions, with a curriculum vitae of more than dozen patents, is Giovanni Faoro, one of the founder heirs IKOI, still family-controlled company, but with balance sheet that rivals many large companies: EBIT growing by 10,3% (to euro 750 thousand), turnover by 15% to 7.3 million. "8% of these are invested in Research & Development," emphasizes CEO Alessandro Stocco.

However Faoro, the president of the company as well as the head of research, describes with passion his latest invention, the ALS AcidLess Separation. "As for the Flameless Tunnel - he says – ALS was born because I saw the hell: factories where people work in ambient temperatures of 70 degree Celsius, with flame and smoke, with the risk of breathing toxic fumes". To separate the Silver from other metals contained in doré, such as gold, lead and zinc, the most widely used method remaine the one introduced in 1883, Faoro says: "The Metals are put into crucibles and separated by chemicals. The most effective, but also the most devastating, is chlorine which, in gaseous form, is the same as that one used the Nazis in the gas chambers".

The ALS method does not use any acid: in other words, we only put the doré in a vacuum chamber. "The various metals - precise Faoro - have different evaporating points and are separated one by one as soon as you create the vacuum". Fast, green and cheap too. "Operating costs can drop up to 60% over traditional methods", Stocco adds.
Three ALS prototypes plants are already in operation, two in Russia and one in Kazakhstan. More than twenty customers have expressed interest in this new product.
"Due to the fact that it is a very innovative technology - explains the CEO - we chose to innovate also the commercial side, offering the possibility of a long-term rental".

S.Bel.

BULLION MAGAZINE

MAGAZINE SPECIALIZED IN THE PRECIOUS METAL INDUSTRY IN INDIA

A Technical Breakthrough and Innovation in Pre-Refining Processes for Gold Alloys with High Silver Content

Alessandro Stocco, Sales Director, Green Technology & Finance LLP

It's "mad[illegible]y" the green revolution that promises to break into the world of precious metals: new machine: AcidLess Se[illegible]n (ALS®), protected by an international patent, which separates the Silver from other metals with which it is extracted without using dangerous and polluting chemicals.

Green Technology & LLP is the worldwide distributor and has the full right to use all patents related to it. The manufactor of the equipments is IKOI Srl the Italian leading company for machines and plants for precious metals treatments well known in the world for his Flameless Tunnel .

ALS® is a striking innovation!

The great innovation of the ALS® is to use the physical principle of vacuum distillation for the separation of silver from other metals with a paradigm shift which for hundreds of years has seen many chemicals used for the refining process of precious metals.

The ALS®technology breakthrough is therefore now more in line with the international guidelines of the environment and with the increasingly strict regulations that the precious metal refining industries must deal with every day.

This revolutionary idea, born from a technological partnership between IKOI Srl and the Russian company EZ-COM, has been developed over the past years and has passed all tests in the field with thousands of hours, to date, in the production phase of the three systems installed and workingfor over

PAMP SA
PRESS RELEASE
(APRIL THE 13TH, 2017)

PAMP
Produits Artistiques Metaux Precieux

Castel San Pietro, 13 aprile 2017, COMUNICATO STAMPA

L'innovazione tutela l'ambiente: PAMP installa uno speciale impianto per separare oro e argento

Quello installato dalla raffineria di metalli preziosi di Castel San Pietro è il primo impianto a livello mondiale realizzato: l'innovativo sistema rivoluziona il processo della prima affinazione, con vantaggi indiscutibili per l'ambiente.

Le aziende IKOI/GT&F hanno installato presso PAMP il primo impianto ALS, Acidless Separation, disponibile sul mercato. La raffineria ticinese ha già collaborato per la messa a punto dell'impianto e delle tecnologie, sperimentando la versione pilota che oggi ha trovato casa proprio a Castel San Pietro.

Il materiale grezzo che giunge presso le raffinerie per essere lavorato è spesso composto da oro, argento e altri metalli: la rivoluzionaria tecnologia "verde" messa a punto da IKOI/GT&F consente nella fase di prima affinazione (pre-refining) di separare l'oro dagli altri metalli preziosi senza l'utilizzo di agenti chimici. Il sistema sfrutta le differenze nella tensione di vapore dei vari metalli, che ne determinano la temperatura di fusione o evaporazione: il metallo grezzo viene posto in un forno inserito in un serbatoio sottovuoto: una volta scaldato ad una temperatura di 1300 gradi, l'argento evapora e viene raccolto in uno speciale filtro, mentre l'oro rimane nel crogiolo. La prima affinazione è così compiuta.

I vantaggi che questa tecnologia comporta sono importanti e sono rintracciabili in una drastica riduzione degli agenti chimici necessari nel processo, in una diminuzione dei consumi energetici legata anche a minori tempi di raffinazione e minori quantità di materiale da affinare, e infine in un calo delle emissioni dirette al sistema di filtraggio. Inoltre, l'impianto chiuso ed isolato garantisce una maggiore sicurezza per gli operatori impiegati nel processo, i quali estraggono i materiali una volta che l'impianto si è raffreddato.

Nadia Haroun, CEO di PAMP, commenta «Anche in un ambito industriale come quello della fonderia, apparentemente legato a processi tradizionali, esiste un margine di miglioramento e innovazione. PAMP è alla costante ricerca di soluzioni nuove che rendano le proprie operazioni sempre più sostenibili, per questo il progetto IKOI/GT&F ci ha da subito visti interessati e in una certa misura coinvolti per il suo perfezionamento».

Per ulteriori informazioni: ufficio stampa
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An MKS PAMP GROUP Company

SOME REAL COMMENTS FROM CUSTOMERS WHO USE OR HAVE TESTED ALS®

Alberto Candiani , Head Refinery Office , PAMP SA – CH

« ALS is exactly the ideal machine to treat our alloy. We will save a lot of money»

Simone Frigerio, Technical Director, ARGOR HERAEUS SA – CH

« production results are positive , *even the OPEX is in line with expectations. It's really the machine that I wanted in the factory »*

Mr. Akihiko Okuda , Chief Operation Office , TANAKA Group – Japan

« I didn't believe it but now I'm definitely surprised on speed and cleanliness of the process »

Mr. Paul Cochineas , Ceo ABC Refinery

« we all are excited to have as soon as possible ALS running in our factory »

Mr. Timur Nurashev, *Ministry of investments and the development of Kazakhstan*

« The ALS AcidLess Separation technology has reduced refining cost by 40% » , talking about the State Refining Tau Ken Altyn

TRIAL TEST ALS 100 KG

WE ARE PREPARING A NEW MACHINE READY FOR YOU. YOU CAN COME AND RUN TESTS WITH YOUR ALLOY.

THANK YOU FOR YOUR ATTENTION