

History of Plasma Arc Technologies – And possible future?

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Electrical furnaces

Relevant for PGM recycling

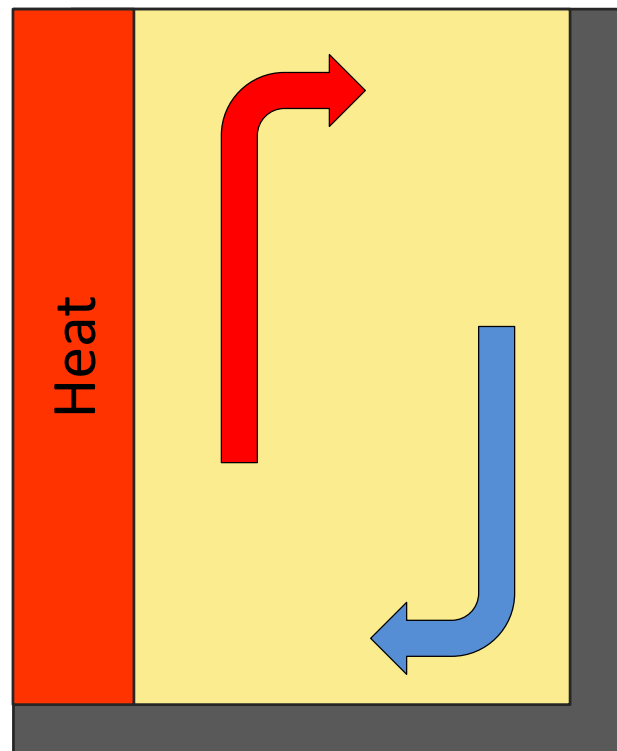
- Electric Arc Furnaces
- DC furnace
- Transferred plasma
 - Open arc
- Non-transferred plasma
 - Internal arc

What is Plasma?

- The fourth fundamental state of matter
- Ionized gas
- Most elements and gases can be ionized
- Ar, He, N₂, O₂, CO, CO₂, H₂ and combinations have been used in various processes

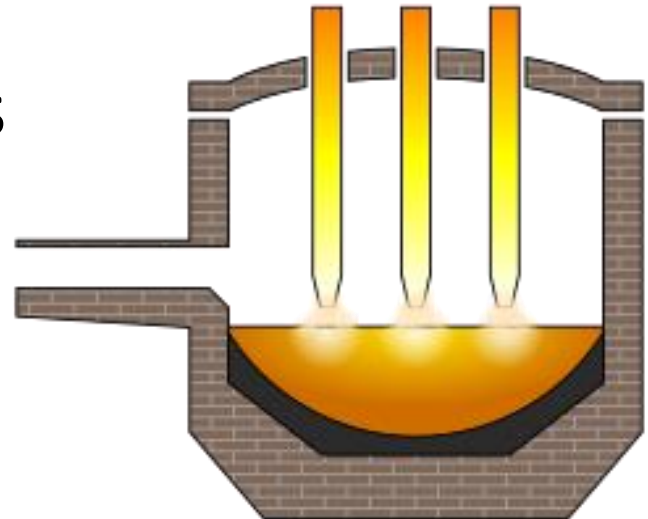
Natural convection

- Bulk movement due to temperature gradients
- Caused by density differences



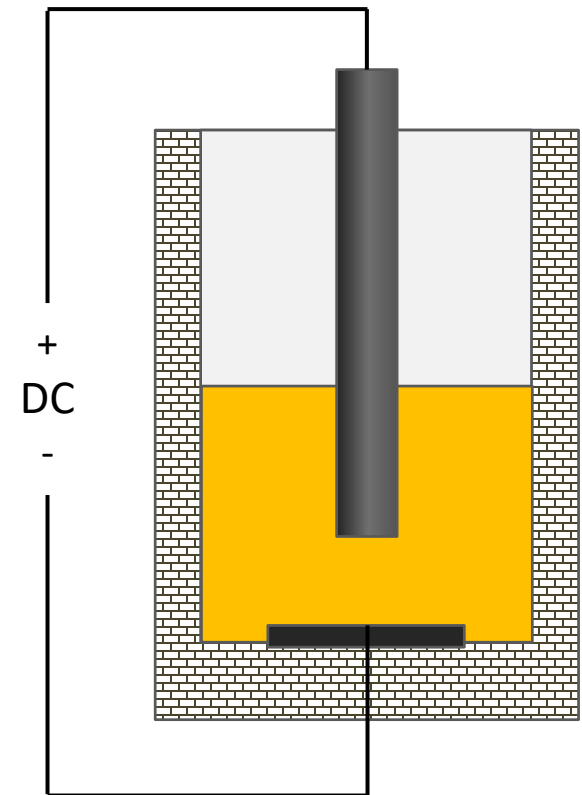
Electric Arc Furnace

- 3 phase AC power
- 3 graphite electrodes
- + High powers
- + Low graphite consumptions
- Heat at top surface



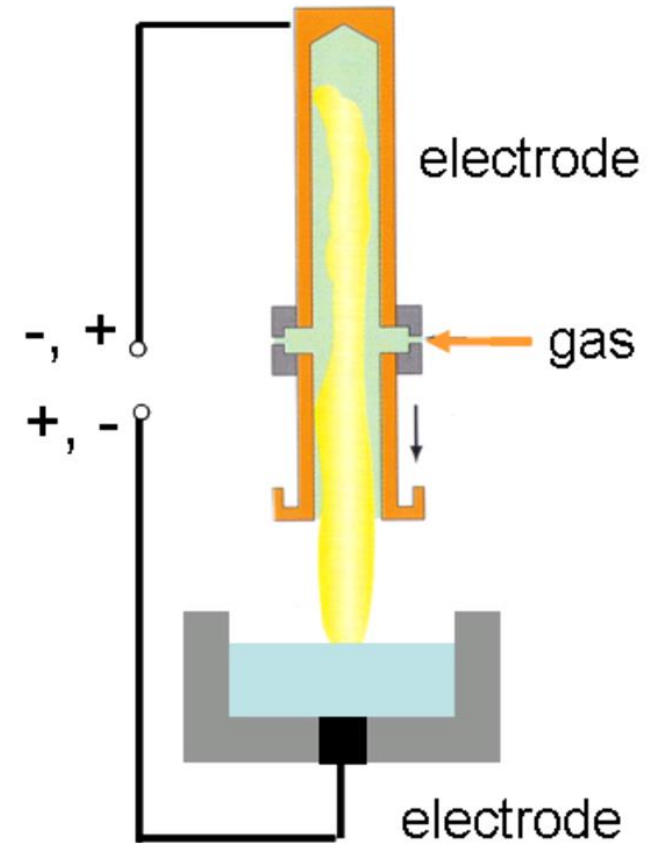
DC furnace

- A single submerged graphite electrode
- + Excellent heat transfer
- + Simple design
- + Good natural stirring
- High graphite consumption



Transferred plasma

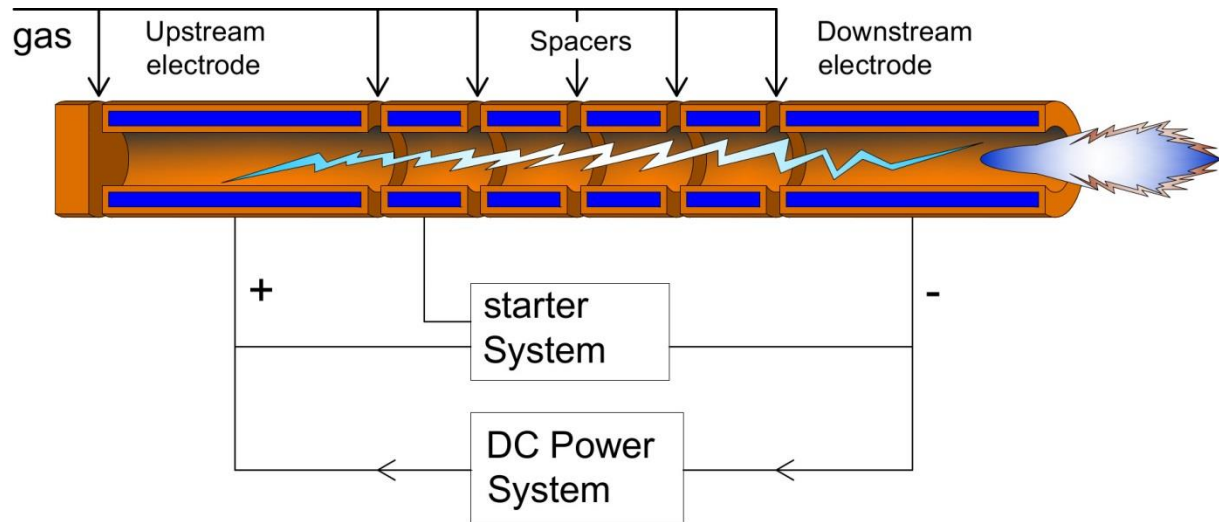
- Open arc
- + Low energy losses
- Temperature on top
- Poor natural stirring



Nickolas J. Themelis, Armelle M. Vardelle

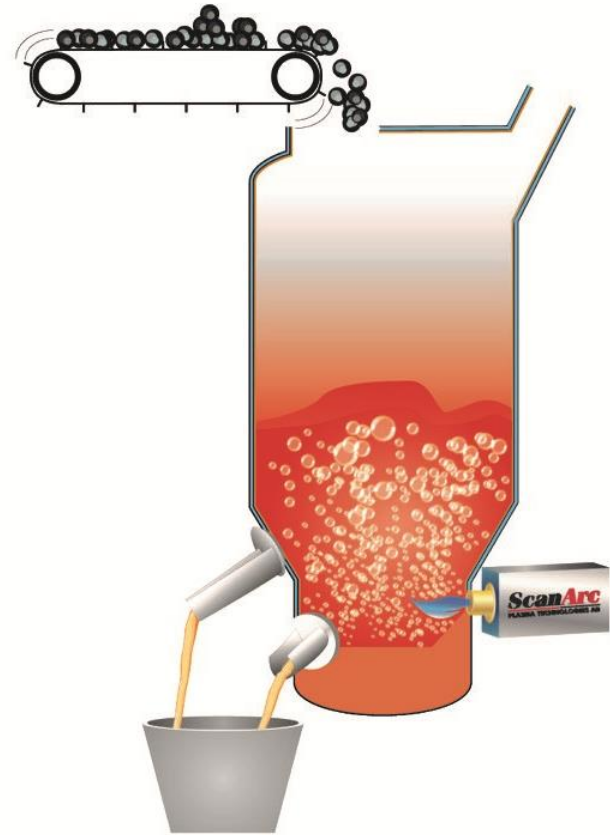
Non-transferred plasma

- Arc generated in a copper tube
- Heat transfer to process by gas



Non-transferred plasma

- + Oxidizing and reducing conditions
- + Vigorous stirring
- High energy losses



ScanArc ArcFume process

Plasma heating advantage

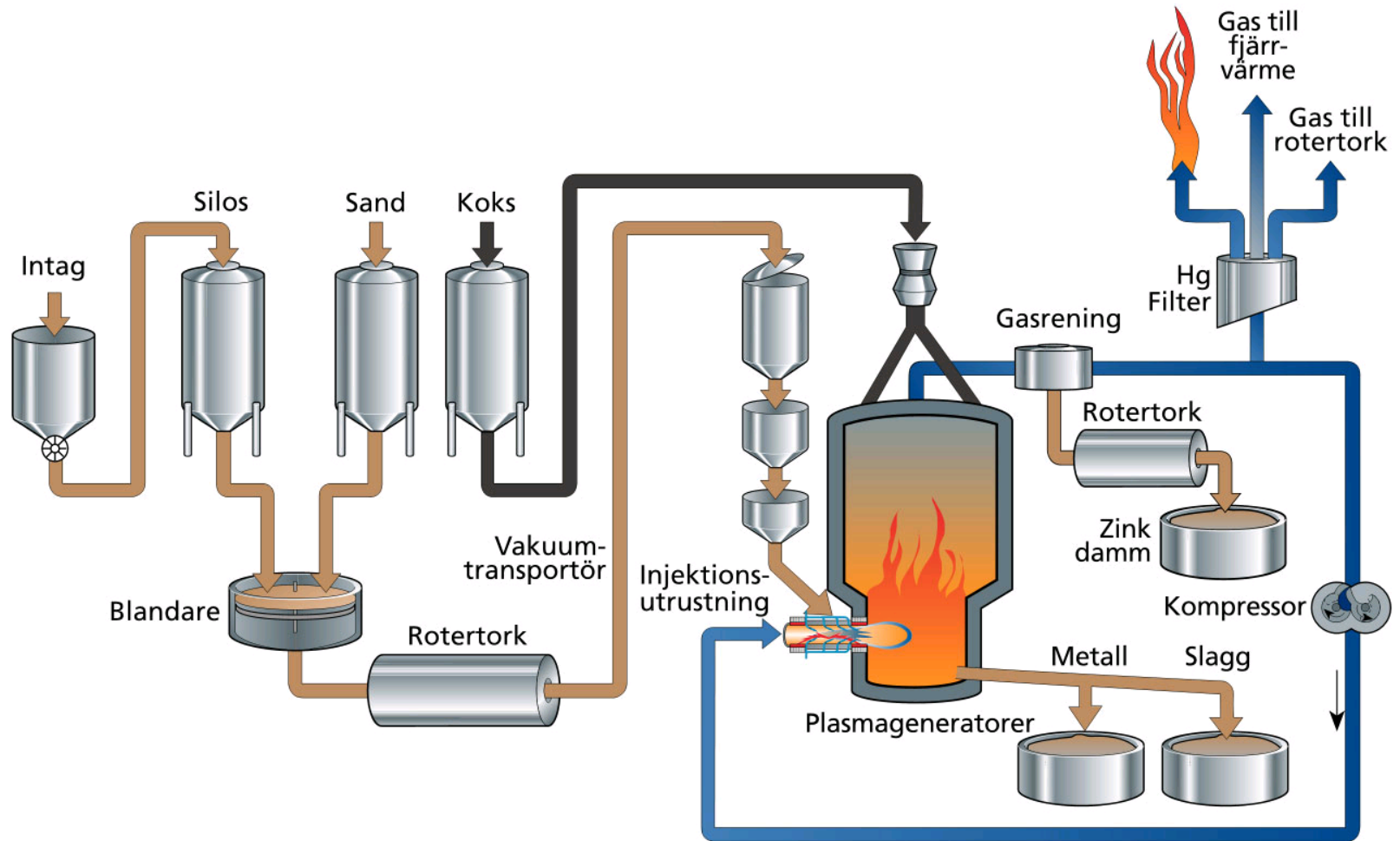
- Can transfer large amount of electricity to heated gas
- High maximum process temperature
- High specific energy, typical industrial value 4kWh/m³

History

- 1906 – First industrial application, to fix atmospheric nitrogen to produce fertilizer
- 1928 – Plasma first named by I. Langumir
- 1972 – SKF Steel wanted an alternative steel production process
- 1984 – First commercial industrial plant, still in operation recycling flue dust from steel plants

Plasma Recycling of flue dust

Befesa Scandust AB



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- **1989 – Scanarc Plasma Technology becomes a company of its own**

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- **1993 – Arc Metal is born as a project in Scanarc, focusing on recovery of PGM from spent auto catalyst**

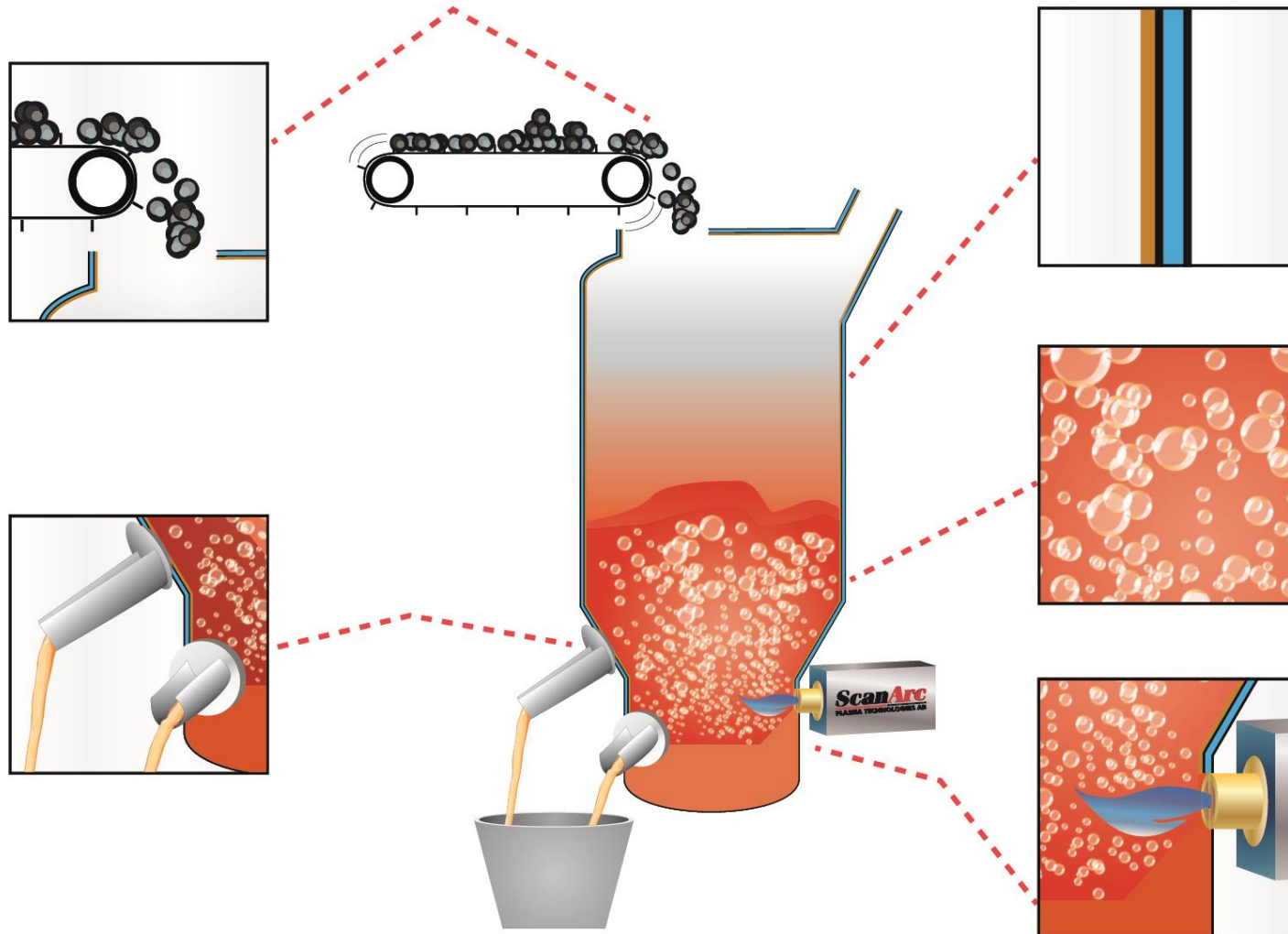
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Arc Fume process



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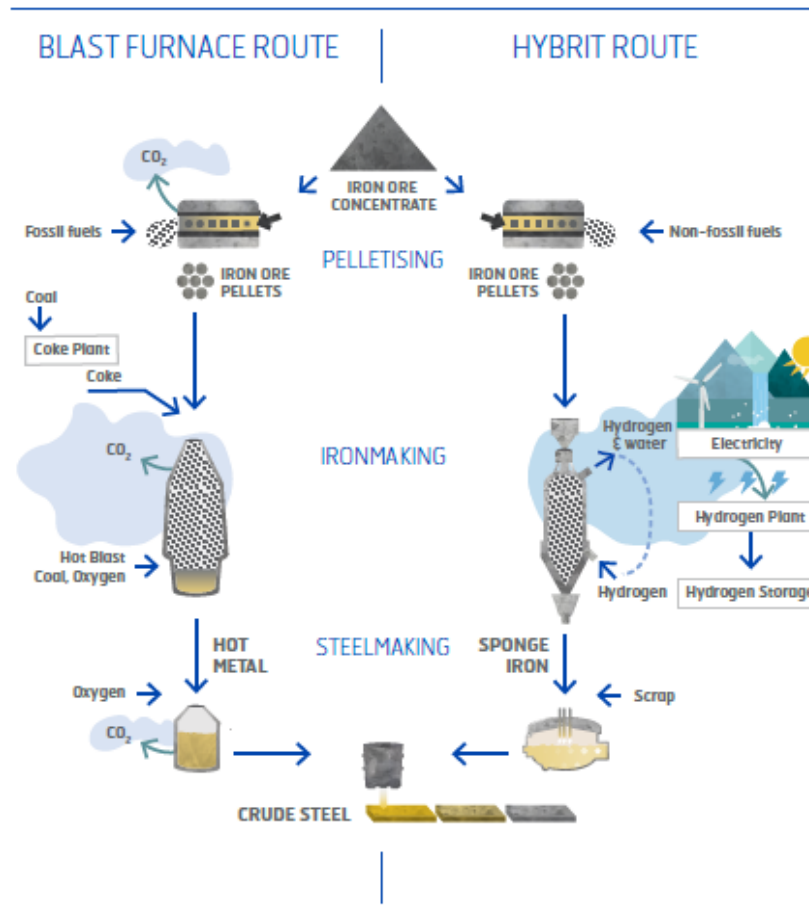
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- **2019 – First commercial step towards processing high carbon containing auto cat mixes to recycle PGM**

And future?

- Novel technologies to decrease carbon footprint
- $\text{Me}_x\text{O}_y + \gamma\text{C} = x\text{Me} + \gamma\text{CO}$
- $\text{Me}_x\text{O}_y + \gamma\text{H}_2 = x\text{Me} + \gamma\text{H}_2\text{O}$
- SiC ?



- Bonus slide



Thank you for listening