Melting Innovation: The Properzi Vert-Melt System

By Davide Iosa*

Today's aluminium car industries may require a furnace set (melter and holder) with low maintenance and low fuel consumption for high production in the range of 5÷10 t/h of rod or billet starting from solid aluminium when molten metal directly from the pot lines is not available.

Analysing the process costs factors, it can be seen that melting of aluminium is the major cost factor within this production process, as such this paper will focus on melting of aluminium that is not only focused on fuel consumption.

The fundamental aspects of melting aluminium on which we should focus our attention are:

1. Melting velocity
2. Metallurgical quality
3. Melt loss
4. Energy consumption
5. Maintenance
6. Manpower
7. Easy operations

It was calculated that for a standard melter, assuming an operating life of 10 years, the investment cost is only 4%, while the most important operational costs are fuel consumption (37%) and the melt loss (42%) for a total of 79%.

Therefore, the research field where CONTINUUS PROPERZI has developed new solutions includes the reduction of melt loss and fuel consumption.

Typical aluminium melting furnace available on the market for a continuous production are:

- *A set of crucible furnaces:*

Low melting rate and very limited crucible capacity

- *A set of reverberatory furnace with wet hearth:*

It uses fuel to melt and overheat the metal through a burner placed at the mouth of the furnace.

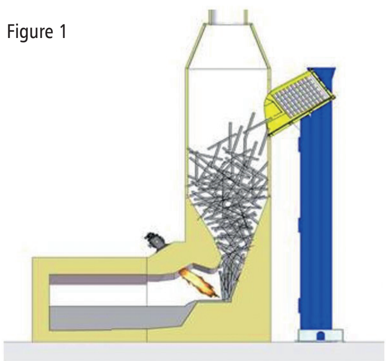
Its heat exchange occurs by radiation and convection.

It has the advantage of having large quantities of liquid metal available as well as the disadvantage of having an oxidised bath with a large quantity of dissolved gases. The metal melted with this type of furnace therefore needs to be treated downstream.

The expected 120 Nm^3 of natural gas consumption per ton of Al, and the melt loss, at 3%, mean that this type of furnace has very high operating costs.

Any type of reverberatory furnace (with or without regenerative burners) has maximum efficiency when the hearth is "dry". As the material melts, the efficiency decreases as the surface area of the charge exposed to combustion fumes also decreases. More than one furnace is needed to provide a continuous flow of molten aluminium.

Figure 1



- *Properzi Vert-Melt Furnace:*

The outstanding thermal efficiency of the aluminium Vert-Melt furnace is even more economically important today, in part because of energy costs but also due to environmental concerns. The Vert-Melt furnace remains the most efficient way of converting solid aluminium to liquid.

Main advantages: compact lay-out, continuous operation, very low melt loss, constant melt temperature, low maintenance costs and ease of operation.

In the Vert-Melt furnace the flame is not in contact with the charge; the combustion fumes heat the charge as they go up to the chimney (it is a heat exchanger):

Furthermore, the material to be loaded into the reverberatory furnaces must be dried before being loaded to avoid the risk of explosion. This is not the case with the Vert-Melt furnace.

Here below, you will find a qualitative evaluation of the characteristics of the furnace based on its type. The Vert-Melt furnace offers the following advantages:

- High efficiency (the efficiency is constant)
- The charge does not need to be dried
- Low melt loss because of less

Primary Al Melting furnace types	Production rate and fast melting rate	Metallurgical quality (low content of oxides and entrapped gases)	Constant melt temperature	Low fuel consumption	Low melt loss	Low personnel cost and ease of operation
Crucible	1	4	2	1	5	1
Dry hearth	4	1	2	2	2	2
Reverberatory						
wet hearth	3	1	1	2	1	2
Induction	5	2	2	1	3	2
Vert-Melt	5	5	5	5	4	5

Table 1

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Figure 2. The Vert-Melt in operation: The Static Holder in front, the Tower Behind

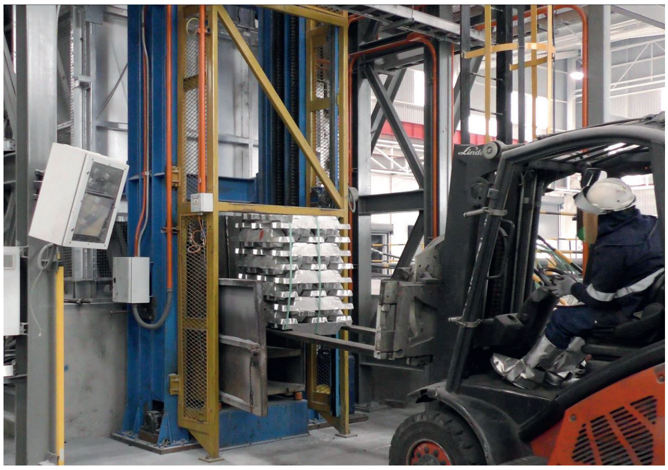

Figure 3. Charging Machine

oxides

- The temperature of the liquid remains constant

Furnace type quality index (scale from 1 to 5 where 1=poor and 5=optimal). **Table 1.**

The result in real life meaning the data from the two plants already in operations since several years confirm the high expectations we had when the project was on the drawing board. **Figures 2** and **3**.

In **Figure 4** is the configuration of the Vert-Melt:

1. Melting tower
2. Skip Hoist Rails
3. Charging platform
4. Charging opening
5. Charging door
6. Chimney
7. Burners
8. Receiving chamber body
9. Main Maintenance door
10. Exit Spout

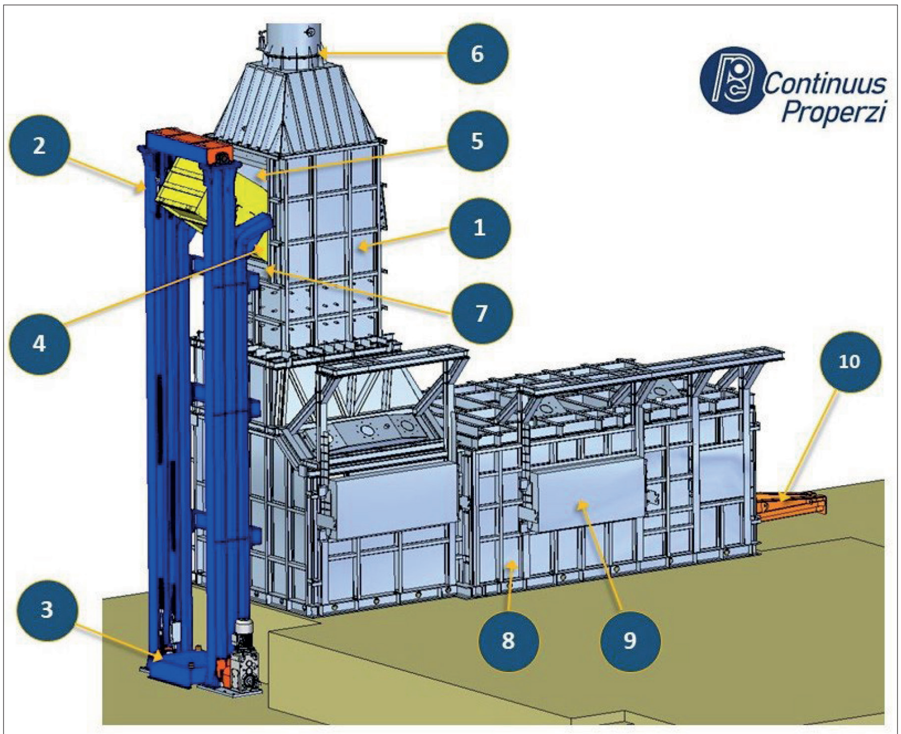

Figure 4. The configuration of the Vert-Melt:
1. Melting tower. 2. Skip Hoist Rails. 3. Charging platform. 4. Charging opening. 5. Charging door. 6. Chimney. 7. Burners. 8. Receiving chamber body. 9. Main Maintenance door. 10. Exit Spout

The charge is introduced from above into a "funnel" which is where the solid charge is supported and melted.

A controlled flow of hot fumes enters this funnel which, passing through the solid charge, generates melting.

As soon as it melts, the material slides on the inclined plane of the melting chamber and accumulates in the collection basin at the bottom, the waiting chamber avoiding any detrimental overheating. The waiting chamber is equipped with a burner independent of the one used for melting. A thermocouple immersed in the liquid bath regulates the power of this burner. Therefore, there is no direct contact between flame

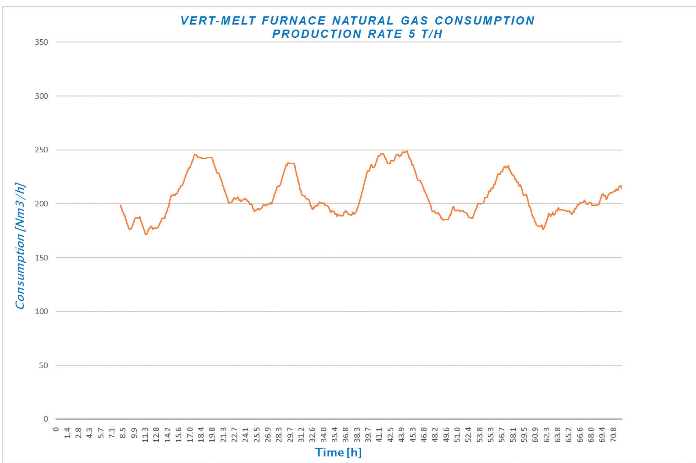

Figure 5

and solid charge. The burner, used for melting, is regulated by a thermocouple, positioned in the chimney, which controls the loading of the furnace. The furnace is loaded when the fumes temperature is approximately 350°C.

Therefore, this melting technology also allows for lower fuel consumption than that of traditional furnaces. Indicatively, we are talking in the range of 60-65 Nm3 of natural gas per ton of liquid aluminium and a decrease of melt loss of 1.5%. Below we have a comparison table that allows you to evaluate the annual monetary savings between the Vert-Melt furnace and the old generation basin type (reverberatory) furnace.

Real time natural gas consumption at a casting rate of 5.0tph during a production campaign of AA1370 H11. The next table shows the real time consumption of NG during a production campaign at 5.0mt/h.

Table 2 (right) shows the difference in annual operating costs relative to: natural gas, electrical energy, and melt loss between the 5tph Properzi Vert-Melt furnace and the traditional reverberatory furnace.

In conclusion, the Vert-Melt furnace provides the most efficient and most economical method for converting solid aluminium to liquid aluminium. The advantages of the Vert-Melt furnace listed in this article facilitates annual savings relative to natural gas, electrical energy, and melt loss when compared to the traditional reverberatory furnace. ■

						PRODUCTION PLANNING	
Specific energy for melting	300,0	kWh/t				Hours/day	24
Specific energy for melting	258.000,0	kcal/t				Days/week	7
Melting rate	5,0	t/h				weeks/year	48
Production per year	40.320	t/year				hours/year	8.064
Net melting power	1.290.000,0	kcal/h				days/year	336
Net melting power	1.500,0	kW				Efficiency	100%

		Cold Air	With recuperator air at 500°C	Regenerative	Oxy fuel	VertMelt
Furnace Efficiency	%	25%	35%	46%	46%	50%
Furnace specific consumption	kWh/t	1.200	857	652	652	600
Furnace specific consumption	kcal/t	1.032.000	737.143	560.870	560.870	516.000
Burners power	kcal/h	5.160.000	3.685.714	2.804.348	2.804.348	2.580.000
Burners power	kW	6.000	4.286	3.261	3.261	3.000
Natural gas flow rate	Nm3/h	600	429	326	326	300
Natural gas specific consumption	Nm3/t	120	86	65	65	60
Natural gas cost per Nm3	€/Nm3	0,27	0,27	0,27	0,27	0,27
Natural gas cost per hour	€/h	162,00	115,71	88,04	88,04	81,00
Natural gas cost per ton	€/t	32,40	23,14	17,61	17,61	16,20
NG cost for melting per year	€/year	1.306.368,00	933.120,00	709.982,61	709.982,61	653.184,00
Oxygen flow rate	Nm3/h	0	0	0	717	0
Oxygen cost per unit	€/Nm3	0,10	0,10	0,10	0,10	0,10
Oxygen cost per hour	€/h	0,00	0,00	0,00	71,74	0,00
O2 cost for melting per year	€/year	0,00	0,00	0,00	578.504,35	0,00
Total cost per hour	€/h	162,00	115,71	88,04	159,78	81,00
Electrical consumption	kWh/t	3,33	4,08	3,11	0,00	1,67
Energy cost per unit	€/kWh	0,07	0,07	0,07	0,07	0,07
Energy cost per ton	€/t	0,23	0,29	0,22	0,00	0,12
Energy cost per year	€/year	9.408,00	11.520,00	8.765,22	0,00	4.704,00
loss for melting	%	3,00	2,00	2,00	2,00	1,50
loss for melting	t	1.209,60	806,40	806,40	806,40	604,80
Al cost	€/kg	1,80	1,80	1,80	1,80	1,80
Melting loss per year	€/year	2.177.280,00	1.451.520,00	1.451.520,00	1.451.520,00	1.088.640,00
TOTAL cost for melting	**€**	**3.493.056,00**	**2.396.160,00**	**2.170.267,83**	**2.740.006,96**	**1.746.528,00**