ALIZADEH ALIREZA
TECHNICAL SALES ENGINEER
DANIELI BREDA

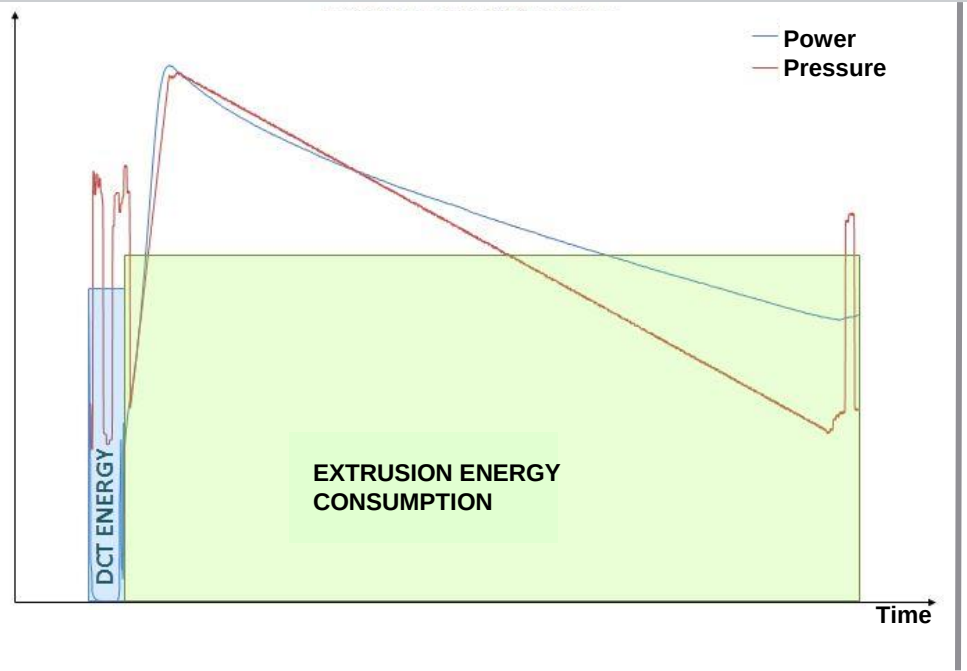
ENERGY SAVING IN EXTRUSION PRESSES
Latest developments

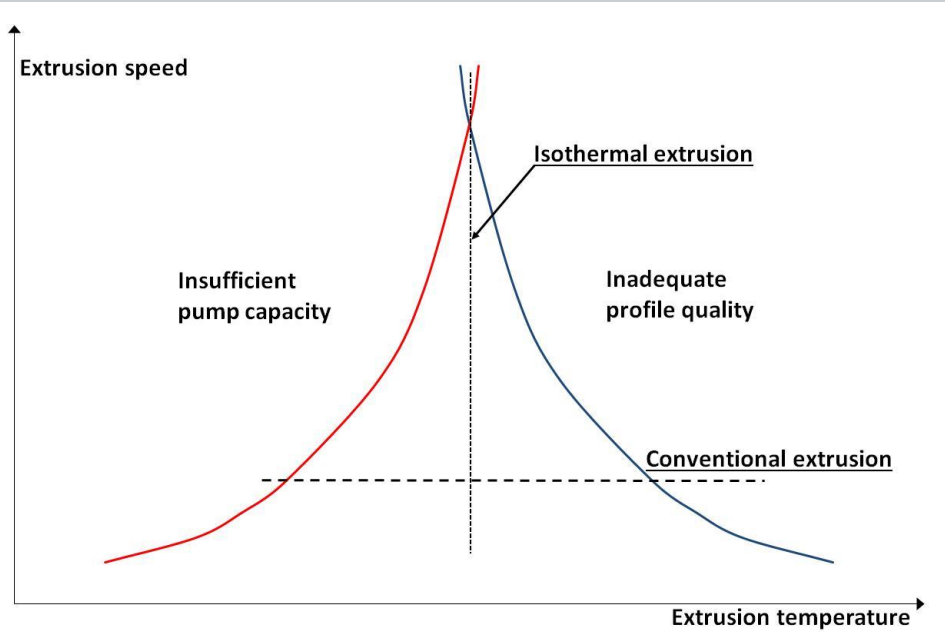
4TH IIAC IRAN INTERNATIONAL ALUMINIUM CONFERENCE
OLYMPIC HOTEL
TEHRAN, IRAN
11-12 MAY 2016

DANIELI
PASSION TO INNOVATE
AND PERFORM
IN THE METALS INDUSTRY

DANIELI TEAM
A CENTURY
OF PARTNERSHIP
EXPERIENCE

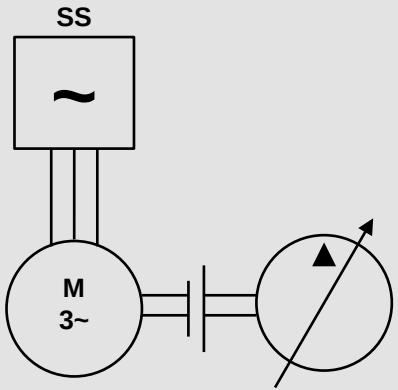
> **Extrusion phase:** Efficiency optimization → energy saving
> **Dead Cycle Time:** Cycle optimization → productivity
> **Isothermal extrusion:** Process control → productivity / quality





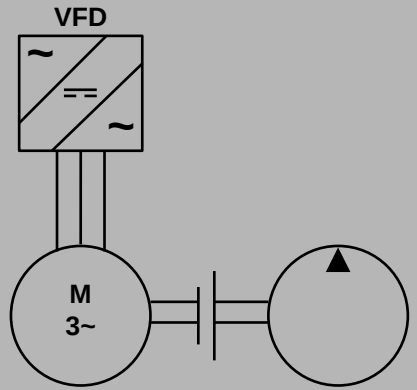
HYDRAULIC DRIVE: STATE OF THE ART

VP+SS



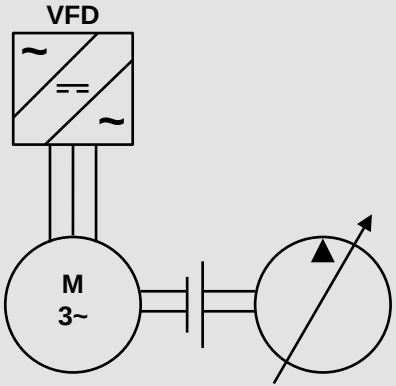
DRIVE:	SOFT STARTER
MOTOR:	ASYNCHRONOUS TRIPHASE
PUMP:	VARIABLE DISPLACEMENT

FP+VFD



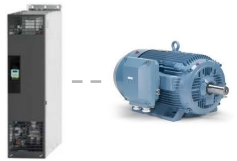
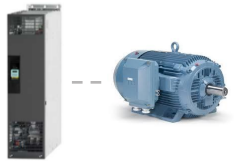
DRIVE:	VARIABLE FREQUENCY DRIVE
MOTOR:	ASYNCHRONOUS TRIPHASE
PUMP:	FIXED DISPLACEMENT

VP+VFD



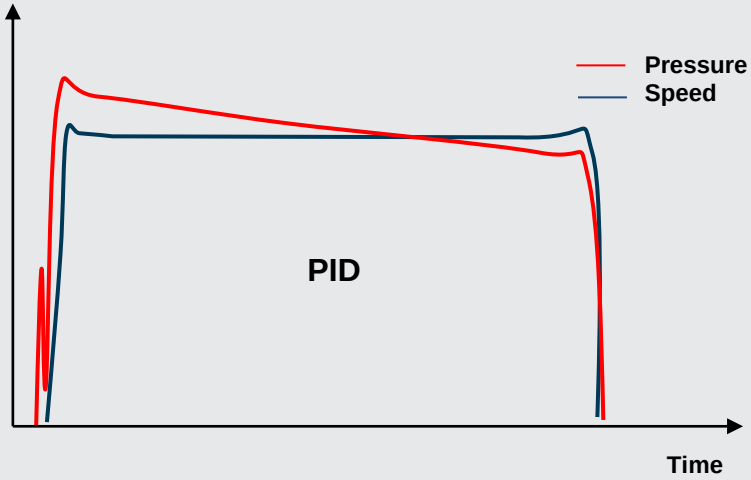
DRIVE:	VARIABLE FREQUENCY DRIVE
MOTOR:	ASYNCHRONOUS TRIPHASE
PUMP:	VARIABLE DISPLACEMENT

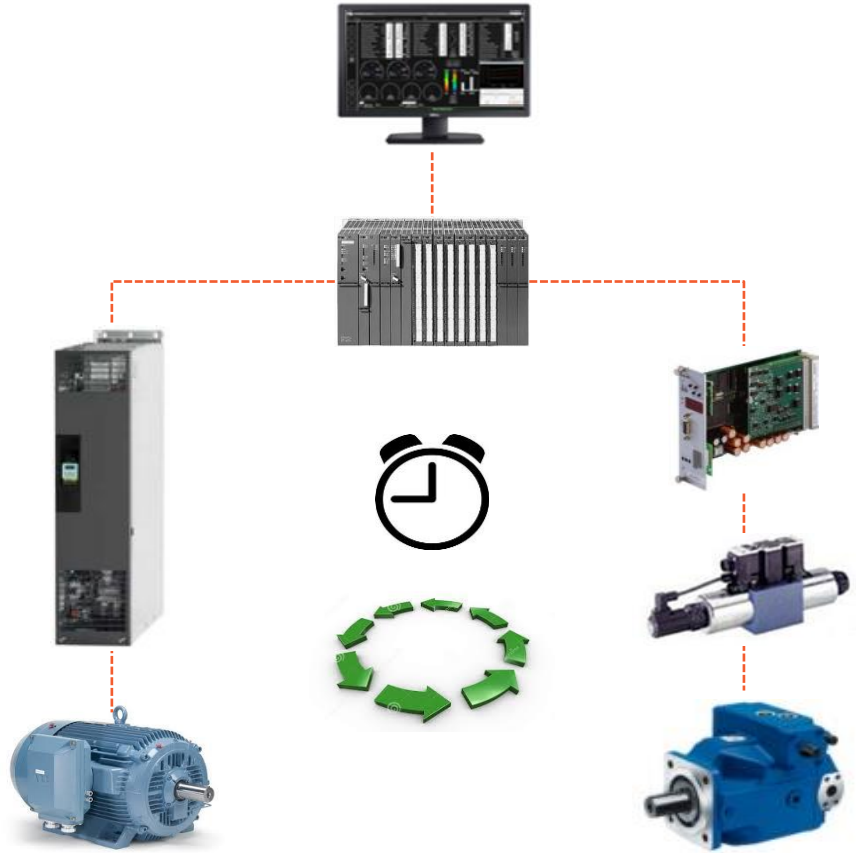
SOLUTIONS COMPARISON

	DRIVE	HYDRAULICS	PROPERTIES
VP+SS	 SOFT START MOTOR DRIVE	 ELECTRONIC CARD, PROPORTIONAL VALVE, VARIABLE PUMP	Simple electronic system Easy implementation on existing plant Low efficiency with low flow rate Poor cosφ Start&Stop reduces pumps life Small pump required for low extrusion speed
FP+VFD	 VARIABLE SPEED MOTOR DRIVE	 FIX PUMP	Easy maintenance Higher speed High cosφ High inverter consumption High cost of big size inverters Lower and more stressing dynamics Small pumps required for low extrusion speed
VP+VFD	 VARIABLE SPEED MOTOR DRIVE	 ELECTRONIC CARD, PROPORTIONAL VALVE, VARIABLE PUMP	Maximum motor and pump efficiency High dynamics, high speed High cosφ Excellent press. & speed control even at low speed No small pump 15-20% saving on installed power

CONTROL PARAMETERS:

> Speed
> Pressure
> Power
> Temperature
> Working hours





Flow rate is a function of swivel angle α

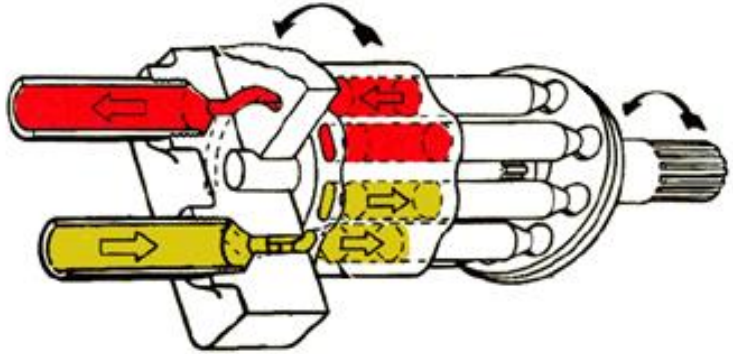
$$Q = \frac{Vp\,(\alpha) * n * \eta_{vol}}{1000}$$

Power is a function of flow rate Q

$$W = \frac{Pa * Q}{600 * \eta_{el}}$$

Q: Flow rate [l/min]
Vp: Displacement [cm³]
n: Ring per minute [rpm]
ηvol: Pump efficiency

W: Power [Kw]
Pa: Pressure [bar]
ηel: Motor efficiency



MAPPING

CONSUMPTION

OPTIMUM

ENERGY SAVING

Mapping on:

> Speed
> Swivel angle
> Pressure
> Torque

η_{hyd}

η_{el}

MAPPING

CONSUMPTION

OPTIMUM

ENERGY SAVING

+

η_{el}

+

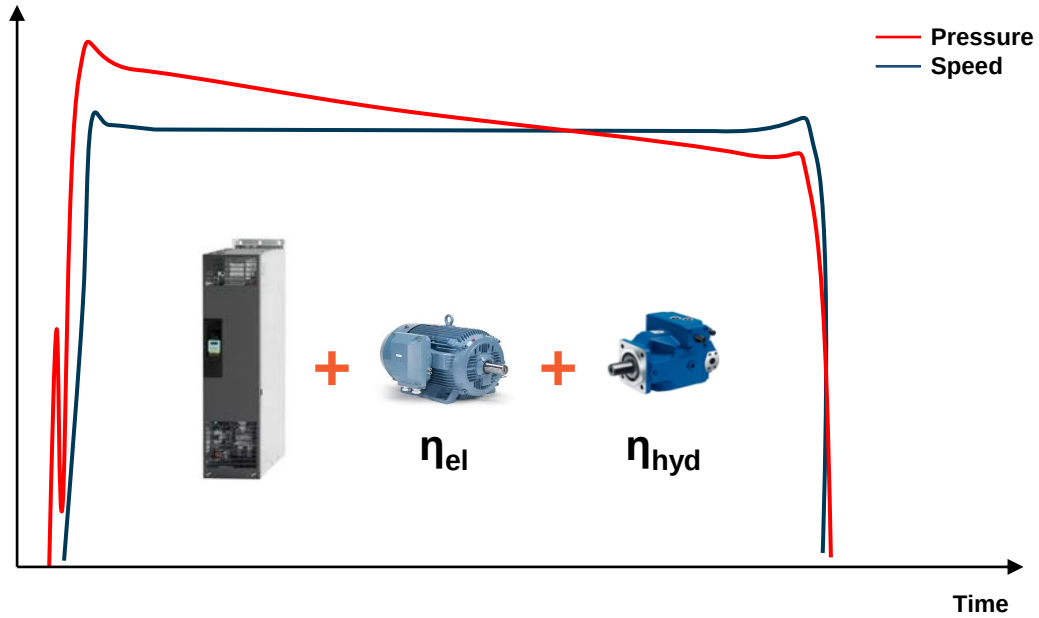
η_{hyd}

MAPPING

CONSUMPTION

OPTIMUM

ENERGY SAVING

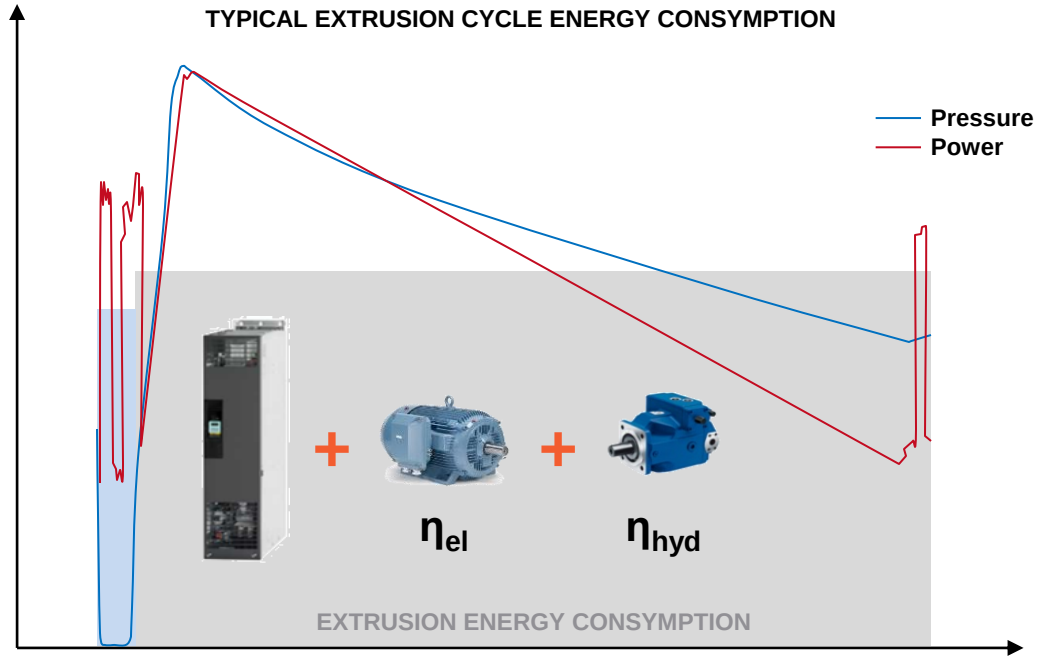


MAPPING

CONSUMPTION

OPTIMUM

ENERGY SAVING



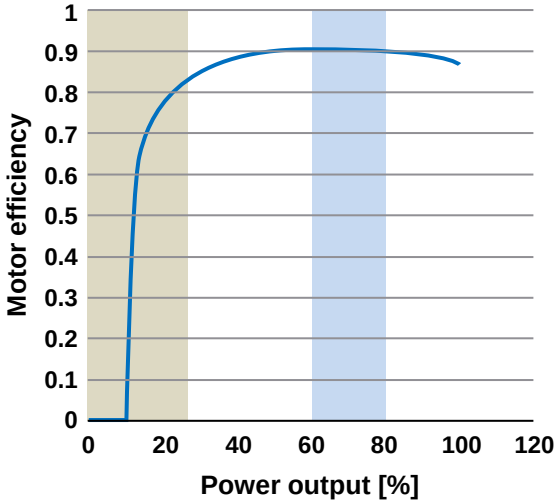
EQUIPMENT

Motor	200 kW 3AC (IE3)
Inverter	Heavy duty
Pump	Servo-variable 250cc
Tank	4000 L

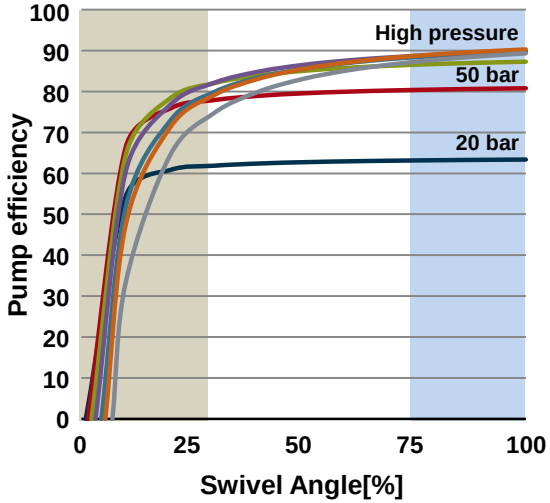
DATA ACQUISITION

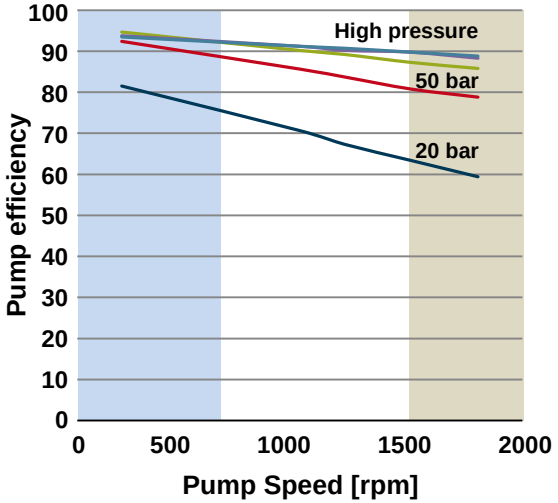
Flow meter	Settima FL32
Current / Power	LEM HAL 600-S
Pressure	HYDAC HDA4445
Acquisition	COMPACT RIO 9081 + 9155

η_{el}



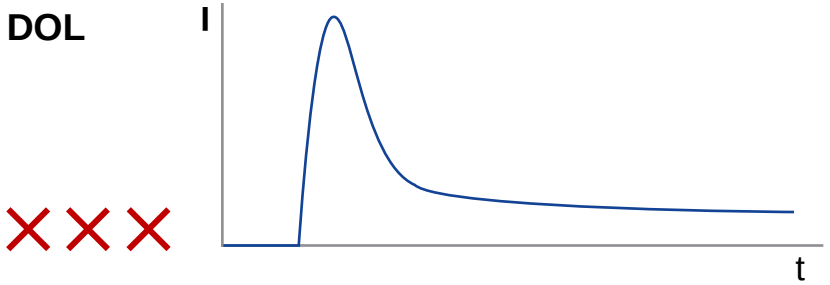
η_{hyd}





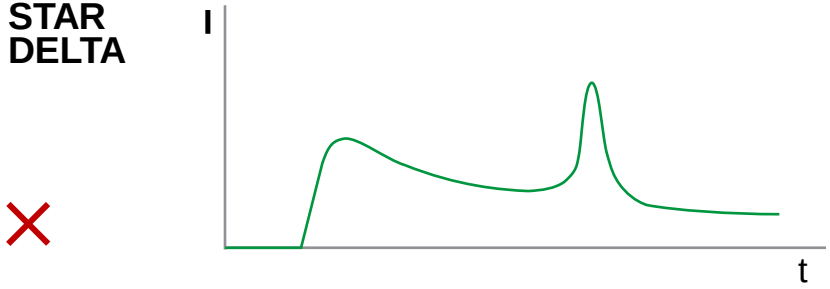
ELECTRICAL DRIVE COMPARISON

DOL

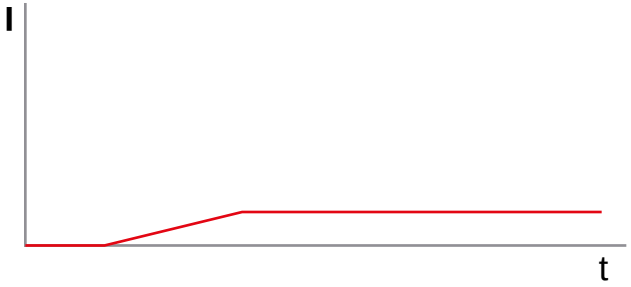


SOFT STARTER

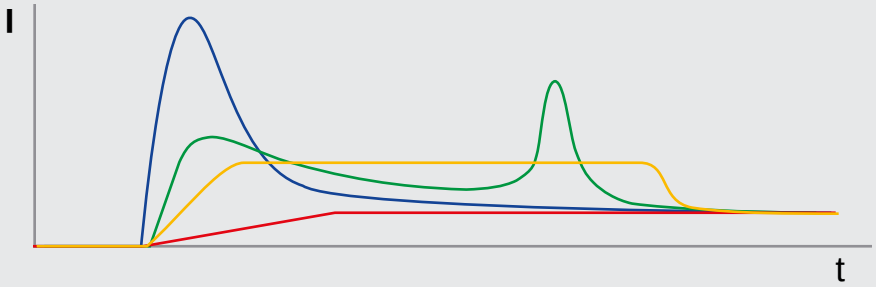
STAR DELTA



INVERTER



COMPARING



EXTRUSION PRESS: MAIN DATA

Press capacity (310 bar / 4,496 psi)	25 (2,810)	MN (UST)
Max. Working Pressure	310 (4,496)	bar (psi)
Operating Pressure	280 (4,061)	bar (psi)
Max Extrusion speed	25 (0.98)	mm/s (in/s)
Extrusion Speed at operating pressure	16,6 (0.65)	mm/s (in/s)
Extrusion Speed at 310bar	15 (0.59)	mm/s (in/s)
Minumum Extrusion Speed	0,2 (0.008)	mm/s (in/s)
Dead Cycle Time > Without burp > With burp	 13 15	 s s

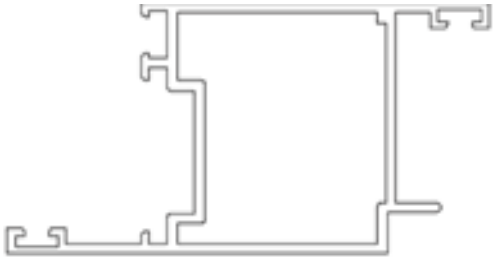
PUMPING UNIT DATA

	CLASSIC		B) VP+SS		C) FP+VFD		D) VP+VFD	
PUMPS	Qty	Power [kW (HP)]	Qty	Power [kW (HP)]	Qty	Power [kW (HP)]	Qty	Power [kW (HP)]
Main (250cc)	4	110 (147.5) at 1,480 rpm	4	110 (147.5) at 1,480 rpm	4	110 (147.5) at 1,480 rpm	4	110 (147.5) at 1,480 rpm
Auxiliary	1	75 (100.6)	1	75 (100.6)	1	75 (100.6)	1	75 (100.6)
Container sealing	1	18.5 (24.8)	1	18.5 (24.8)	1	18.5 (24.8)	1	18.5 (24.8)
Piloting	1	45(60.3)	1	45(60.3)	0	-	0	-
Main Small	1	75 (100.6)	1	75 (100.6)	1	75 (100.6)	1	-
Cool and Filter	1	30 (40.3)	1	30 (40.3)	1	30 (40.3)	1	30 (40.3)
TOTAL		683.5 (916.6)		683.5 (916.6)		638.5 (856.2)		563.5 (755.7)

PRODUCT MIX 1 GENERAL EXTRUSION

Typical Alloys:
EN AW 6060, 6063

Typical Specific pressure:
500÷650 N/mm² (73÷94 kpsi)

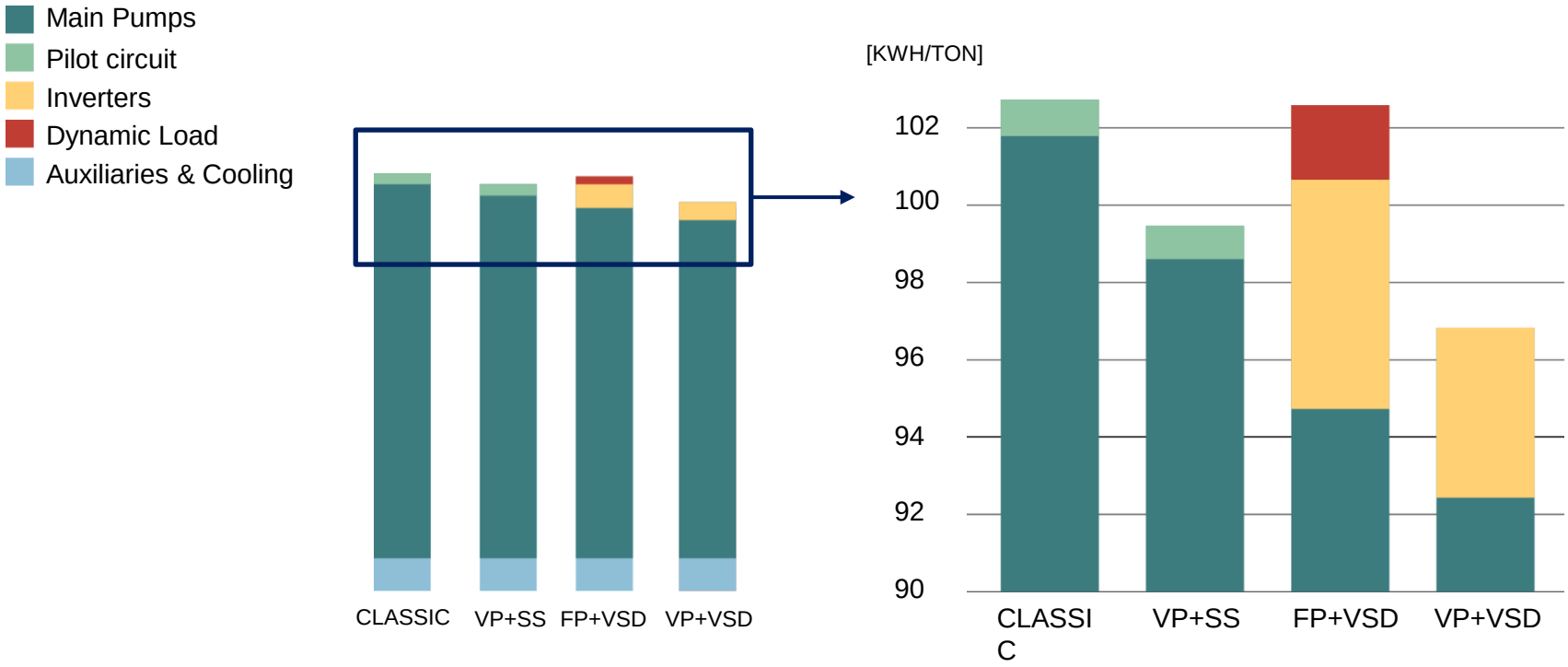


Die changing: every 30 billets
Die changing time: 30 s

Product Mix	Average Extrusion Pressure	Extrusion Speed
40%	280 Bar (4,061 psi)	5 mm/s (0.20 in/s)
50%	250 Bar (3,626 psi)	7.5 mm/s (0.30 in/s)
20%	200 Bar (2,901 psi)	15 mm/s (0.59 in/s)

THEORETICAL ENERGY CONSUMPTION [KWH/TON]	CLASSIC	VP+SS	FP+VSD	VP+VSD
Main Pumps	93.5	90.3	86.4	84.3
Pilot circuit	0.9	0.9	-	-
Inverters	-	-	5.9	4.3
Dynamic Load	-	-	1.9	-
Auxiliaries & Cooling	8.1	8.1	8.1	8.0
TOTAL ENERGY / Aluminum Ton	**102.5**	**99.3**	**102.3**	**96.6**
Advantage respect to Classic	**-**	**3%**	**-0%**	**6%**

PRODUCT MIX 1 GENERAL EXTRUSION



PRODUCT MIX 2 AUTOMOTIVE ALLOY

Typical Alloys:
EN AW 6106, 6082, 7003

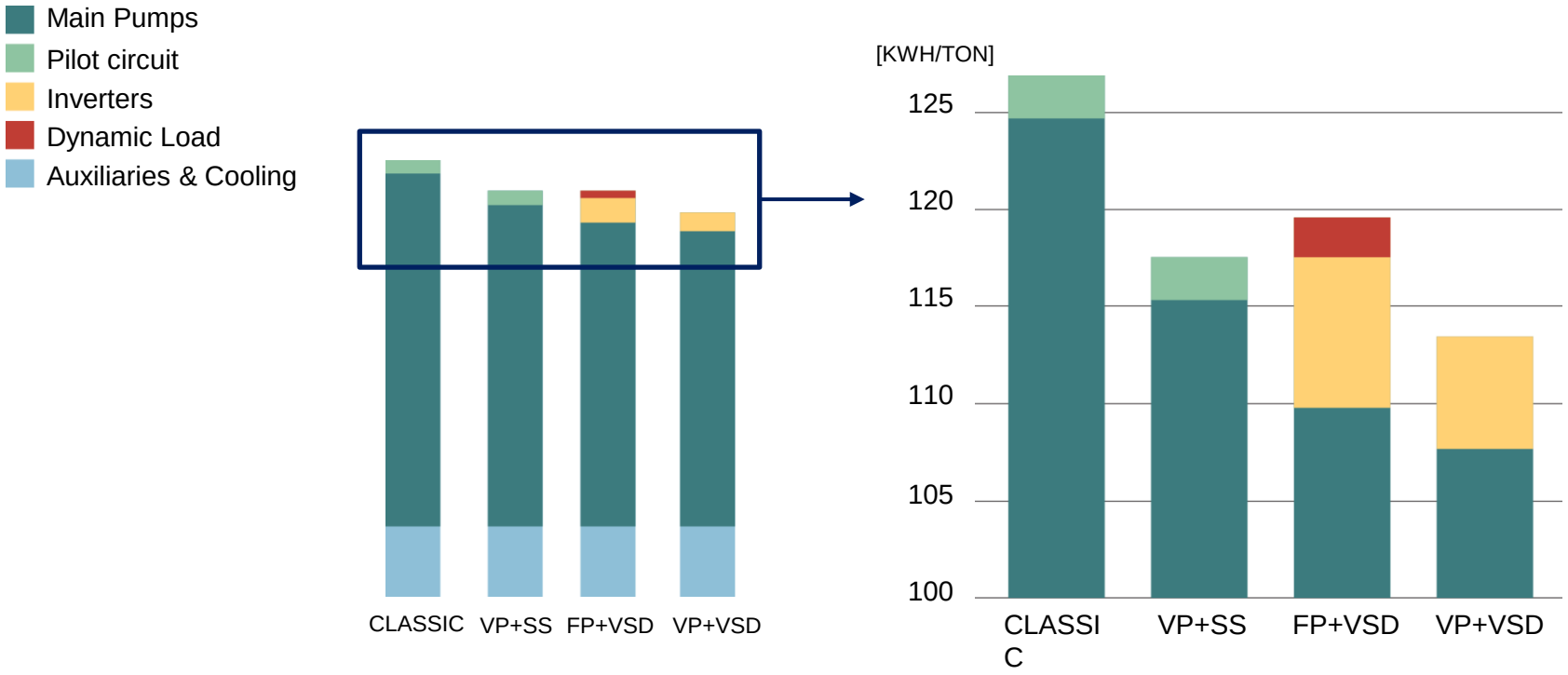
Typical Specific pressure:
650÷900 N/mm² (94÷131 kpsi)

Die changing: every 30 billets
Die changing time: 30 s

Product Mix	Average Extrusion Pressure	Extrusion Speed
35%	280 Bar (*4,061 psi*)	1.5 mm/s (*0.06 in/s*)
40%	270 Bar (*3,916 psi*)	3.5 mm/s (*0.14 in/s*)
20%	250 Bar (*3,626 psi*)	6 mm/s (*0.24 in/s*)
5%	200 Bar (*2,901 psi*)	15 mm/s (*0.59 in/s*)

THEORETICAL ENERGY CONSUMPTION [KWH/TON]	CLASSIC	VP+SS	FP+VSD	VP+VSD
Main Pumps	105.8	96.5	90.7	88.6
Pilot circuit	2.1	2.1	-	-
Inverters	-	-	7.8	5.8
Dynamic Load	-	-	1.8	-
Auxiliaries & Cooling	19	19	19	18.9
TOTAL ENERGY / Aluminum Ton	**126.9**	**117.5**	**119.3**	**113.4**
Advantage respect to Classic	**-**	**7%**	**6%**	**11%**

PRODUCT MIX 2 AUTOMOTIVE ALLOY



PRODUCT MIX 3
MICRO MULTI PORT

Typical Alloys:
EN AW 1050, 1070, 1100, 3003, 3103

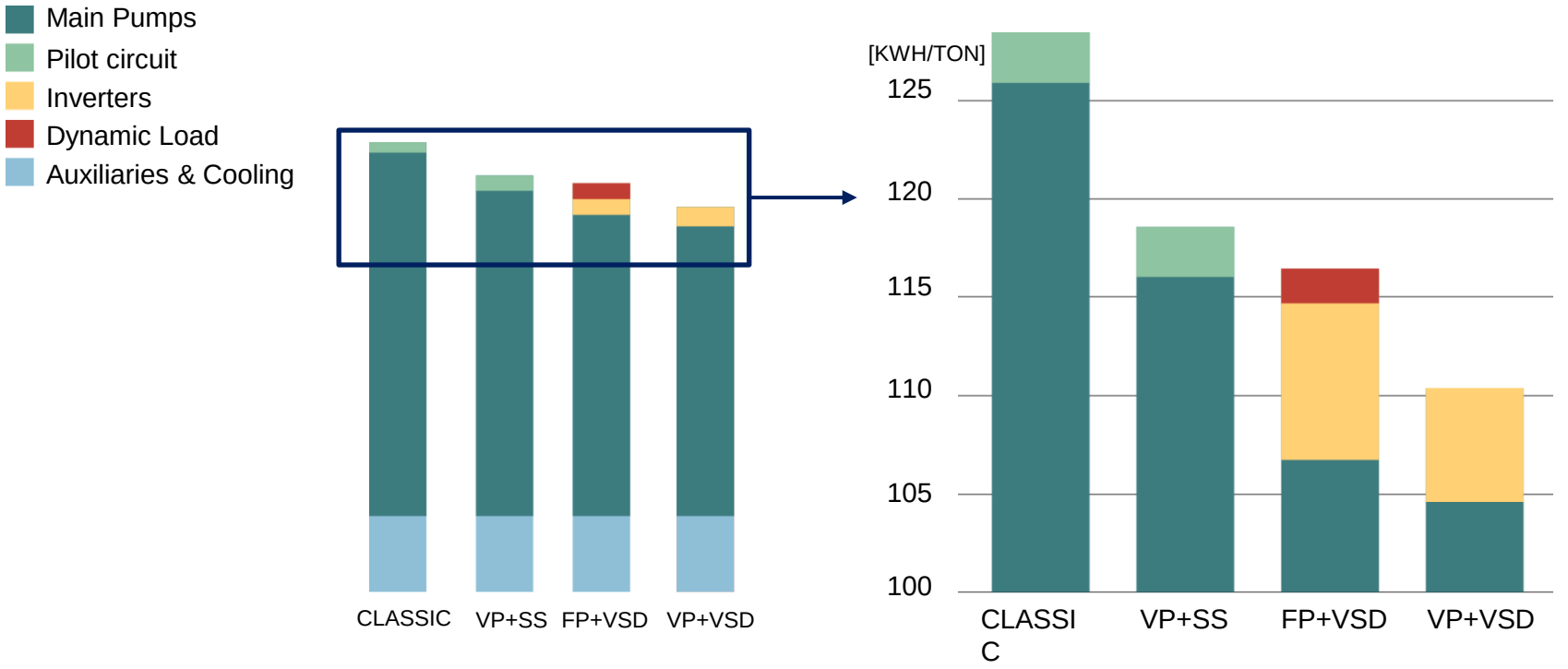
Typical Specific pressure:
400÷600 N/mm^2 (58÷87 kpsi)

Coil discharging: every 15 billets
Coil discharging time: 15 min

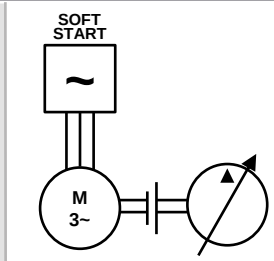
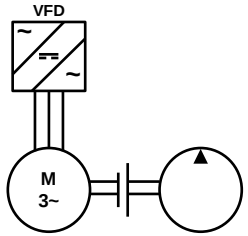
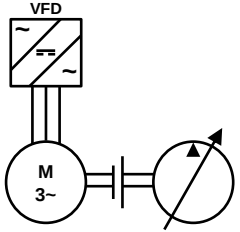
Product Mix	Average Extrusion Pressure	Extrusion Speed
30%	280 Bar (4.061 psi)	1 mm/s (0.04 in/s)
45%	280 Bar (4.061 psi)	4 mm/s (0.16 in/s)
20%	250 Bar (3.626 psi)	7.5 mm/s (0.30 in/s)
5%	200 Bar (2.901 psi)	15 mm/s (0.59 in/s)

THEORETICAL ENERGY CONSUMPTION [KWH/TON]	CLASSIC	VP+SS	FP+VSD	VP+VSD
Main Pumps	104.4	94.8	85.5	83.5
Pilot circuit	2.3	2.3	-	-
Inverters	-	-	7.8	5.8
Dynamic Load	-	-	1.7	-
Auxiliaries & Cooling	21	21	21.1	21
TOTAL ENERGY / Aluminum Ton	**127.8**	**118.1**	**116.1**	**110.4**
Advantage respect to Classic	**-**	**8%**	**9%**	**14%**

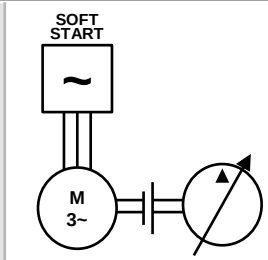
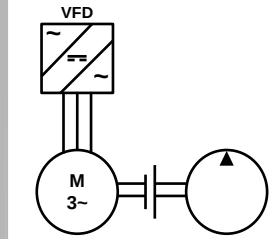
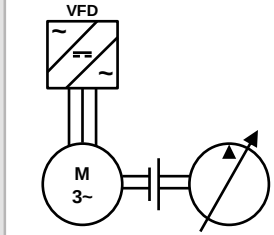
PRODUCT MIX 3 MICRO MULTI PORT



DISCUSSION: ENERGY & ENVIRONMENT

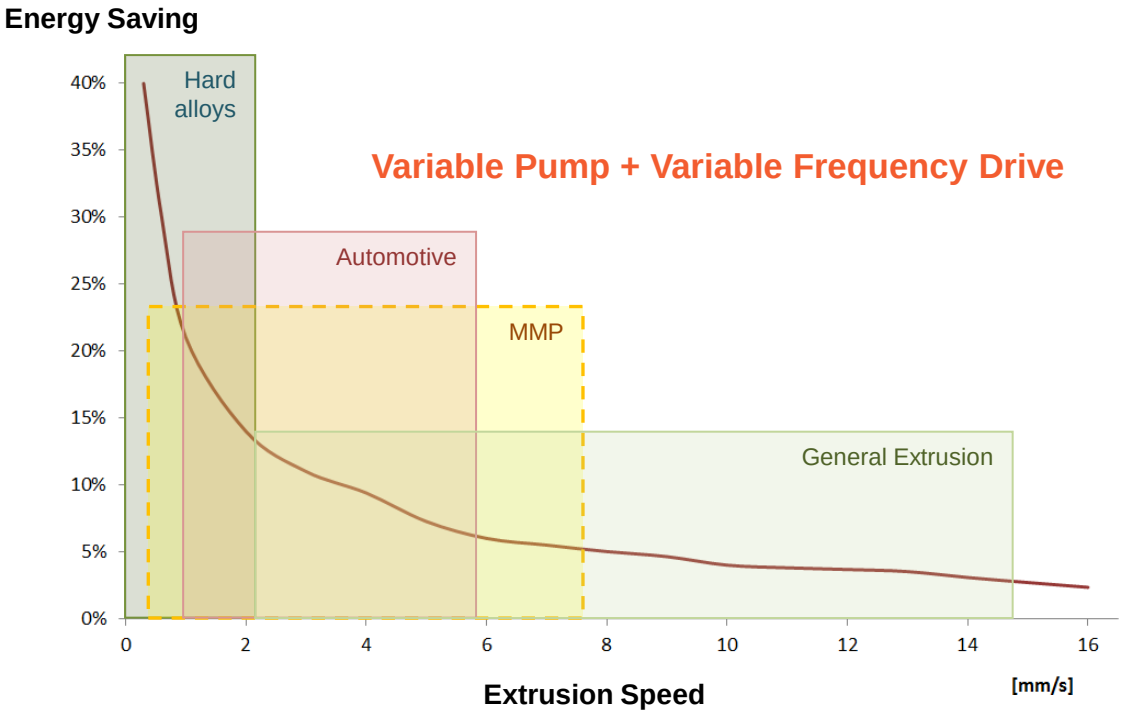
		MOTOR & PUMP EFFICIENCY	INVERTER	INSTALLED POWER	COSΦ	NOISE	SUMMARY
VP+SS		✗	-	✓	✗	✗	✓
FP+VFD		✓	✗	✓	✓✓	✓✓	✓
VP+VFD		✓✓✓	✓	✓✓✓	✓✓	✓✓	✓✓✓

DISCUSSION: TECHNOLOGICAL PERFORMANCES

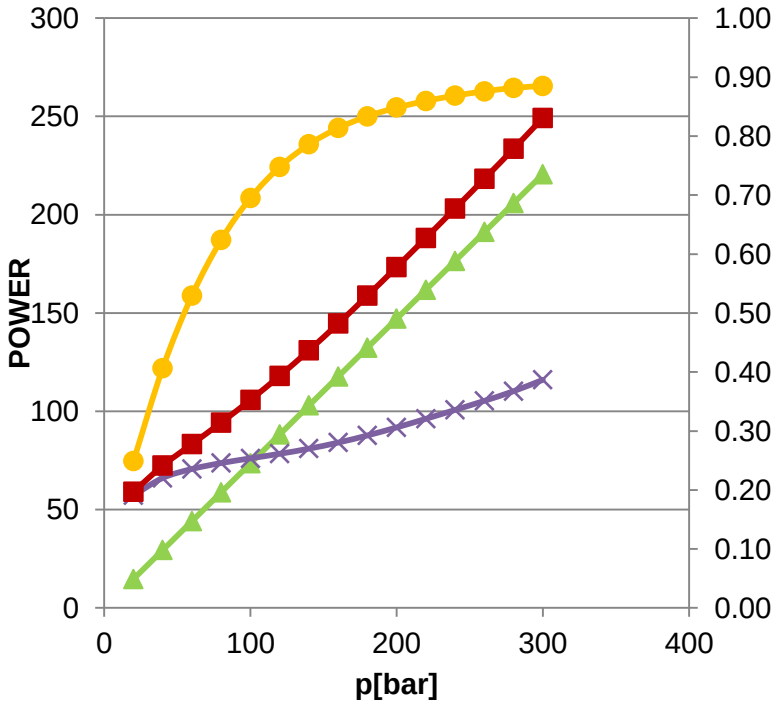
		PRESSURE CONTROL	DYNAMIC PERFORMANCES	DEAD CYCLE TIME	SUMMARY
VP+SS		✓✓	✓✓✓	✓✓	✓✓
FP+VFD		✓	✓	✓	✓
VP+VFD		✓✓✓	✓✓✓	✓✓✓	✓✓✓

VP + VFD: ACHIEVEMENT

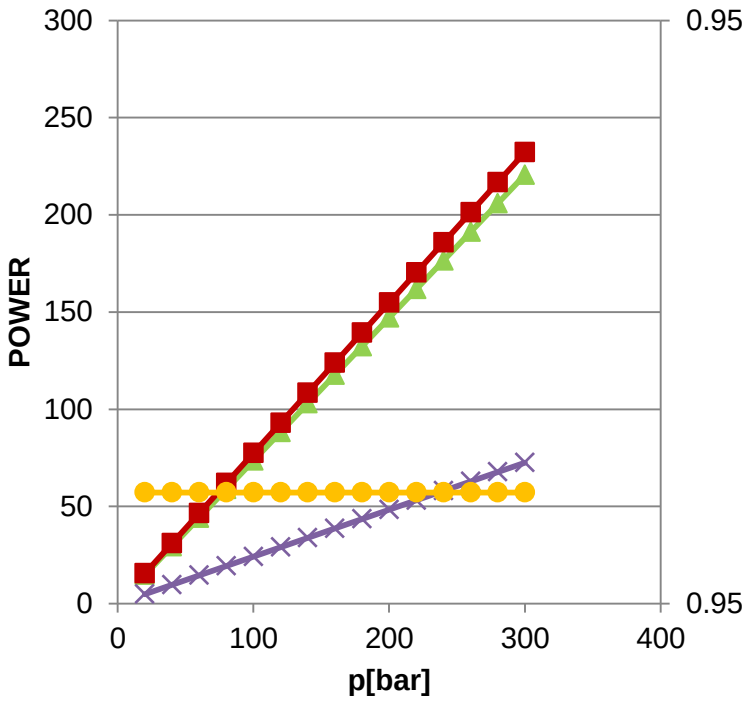
- Energy saving 5% ÷20%, up to 40%
- Installed power saving 15-20%
- High dynamic response
- Fine extrusion pressure regulation
- Reduced DCT



PUMP AT 100% OF DISPLACEMENT WITHOUT VFD

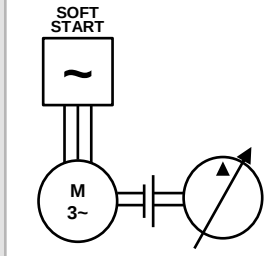
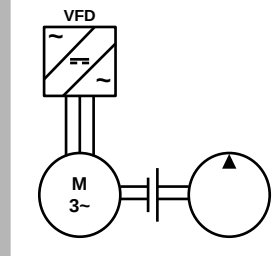
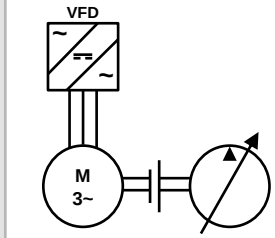


PUMP AT 100% OF DISPLACEMENT WITH VFD



Active Power [kW] Reactive Power [kVAr] TotPower [kVA] cosφ

DISCUSSION: CAPEX & MAINTENANCE

		HYD. SAVINGS	EL. SAVINGS	MAINTENANCE	DURABILITY RELIABILITY	SUMMARY
VP+SS		✗	✓✓	✓	✗	✗
FP+VFD		✓✓	✗	✓✓	✓	✓
VP+VFD		✓✓	✓	✓	✓✓✓	✓✓

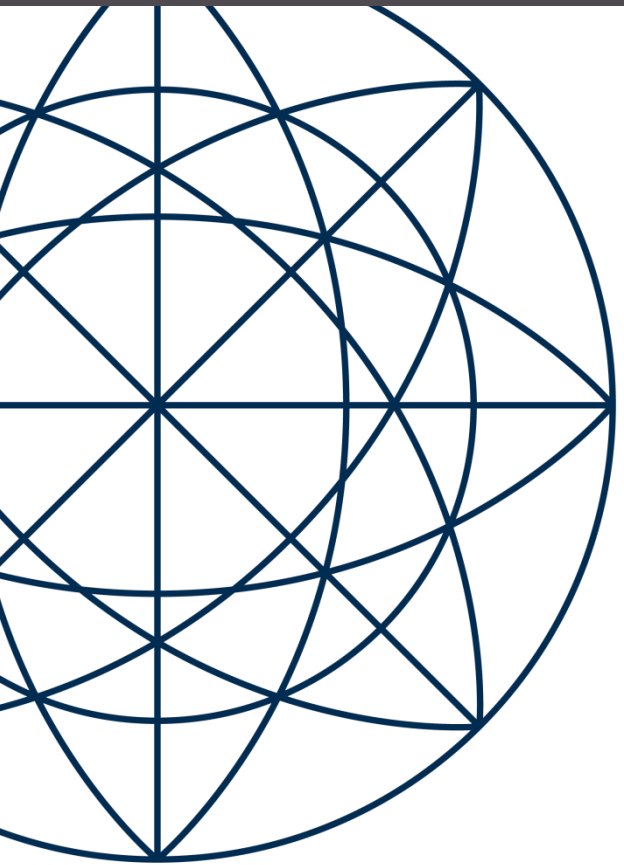
DISCUSSION: CAPEX & MAINTENANCE

VARIABLE PUMP + VARIABLE FREQUENCY DRIVE

- Optimized drives
- Highest equipment life
- 5-20% saved installed power
- No pilot pump
- No small main pump

SPEED LIMITED TO 1800 RPM MEANS

- No booster pumps
- Standard AC motor, NO water cooling
- Reduced noise emission
- Pumps life >20000h compared to 6000h working at 2500 rpm

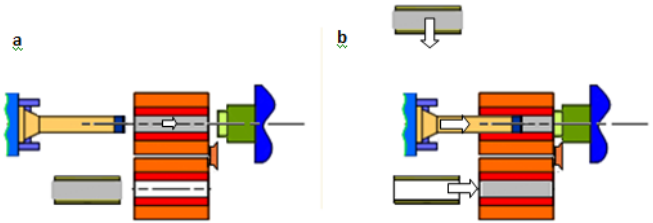


> **Variable Displacement Pumps + Variable Frequency Drive (VP+VFD)** stands out as the best performing solution, offering clear advantages in terms of energy savings (5-20%), installed power (15-20%), cosφ, dynamic response, pump life.

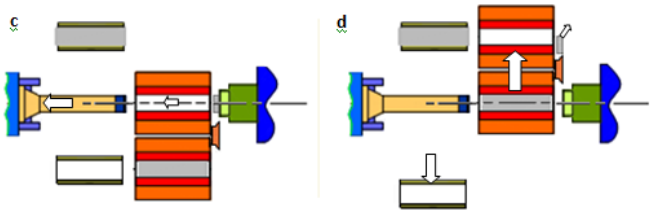
> This solution is also easily applicable to existing presses, either focusing
on a contained low-cost revamping or integrating it into a wider press modernization concept.

T-WIN: DOUBLE CONTAINER EXTRUSION PRESS

Billet loading into container N. 2 while container N. 1 is involved in extrusion



Container N. 2 shifted and billet ready for extrusion, container N. 1 ready for cleaning and new billet loading



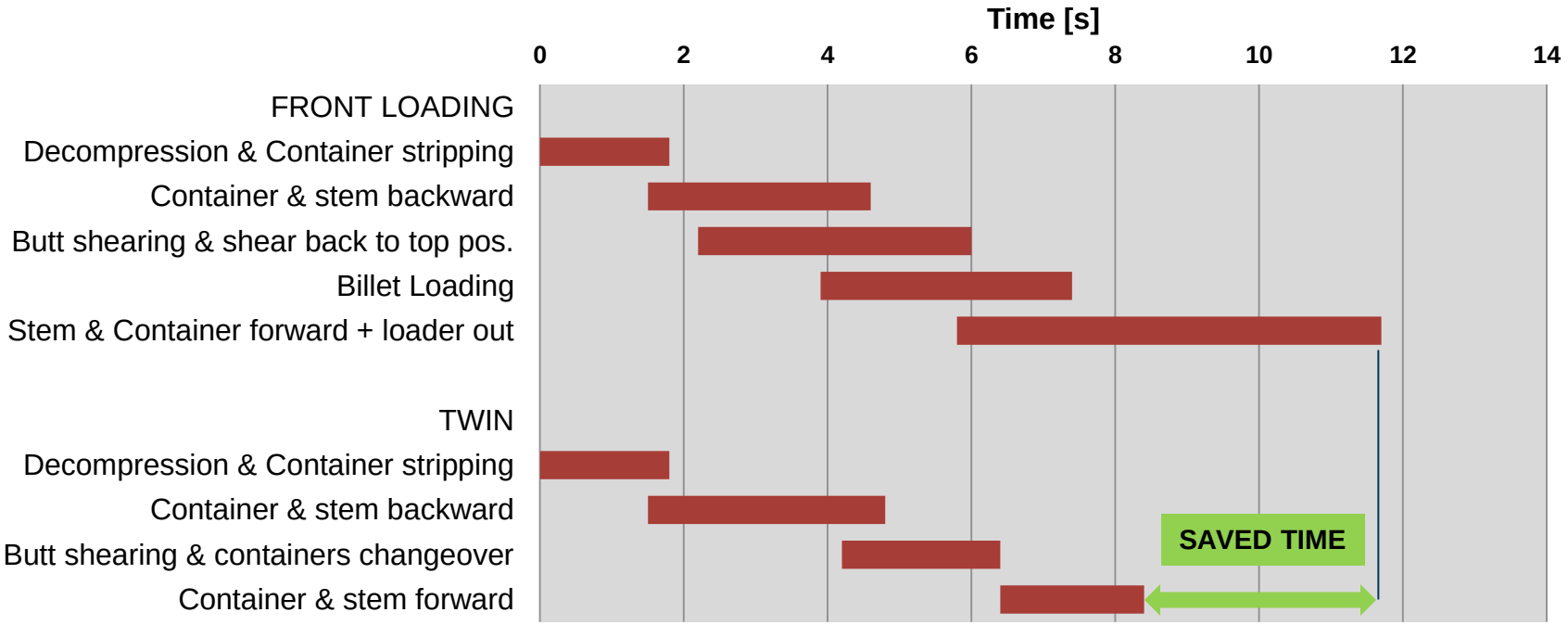
		Standard FL	T-WIN
Dead time at upset start	[s]	11.7	8.4
Dead time without burp	[s]	13.5	9.8
Dead time at burp end	[s]	15.5	**11.5**
Energy consumption during DCT	[kWh]	0.56	0.41

30 billets/h, 16 h/d, 288 d/y

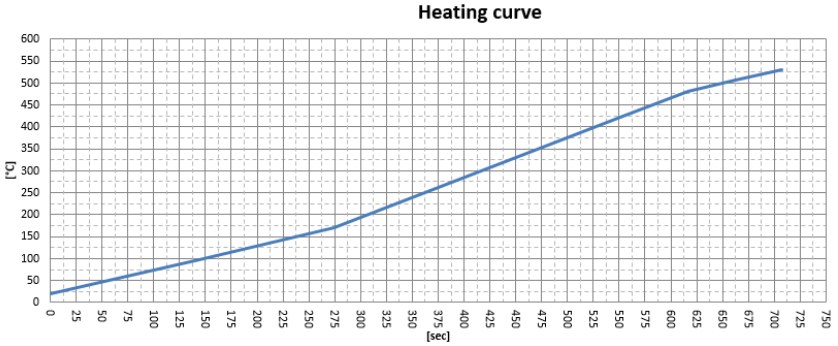
4 s less in DTC → 134 h/y saved

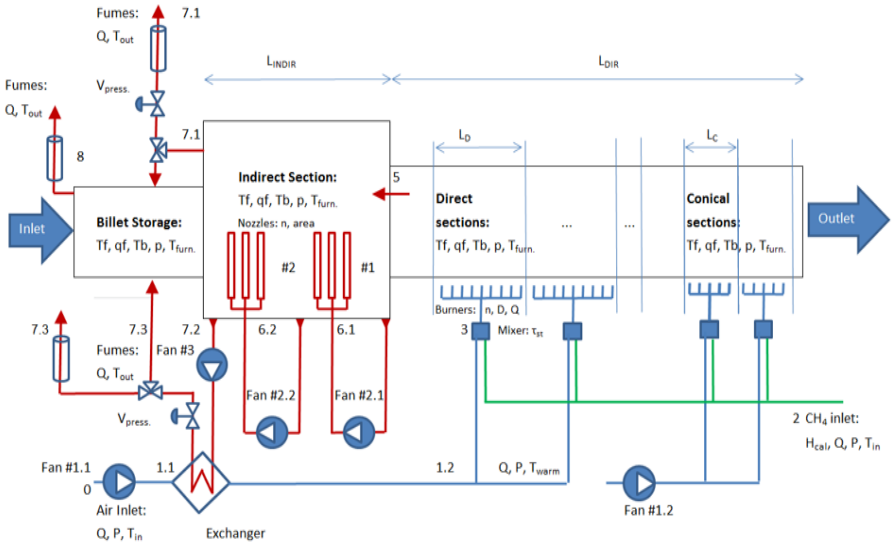
more than 4,000 billets
more than 20,000 kWh saved

DEAD CYCLE TIME

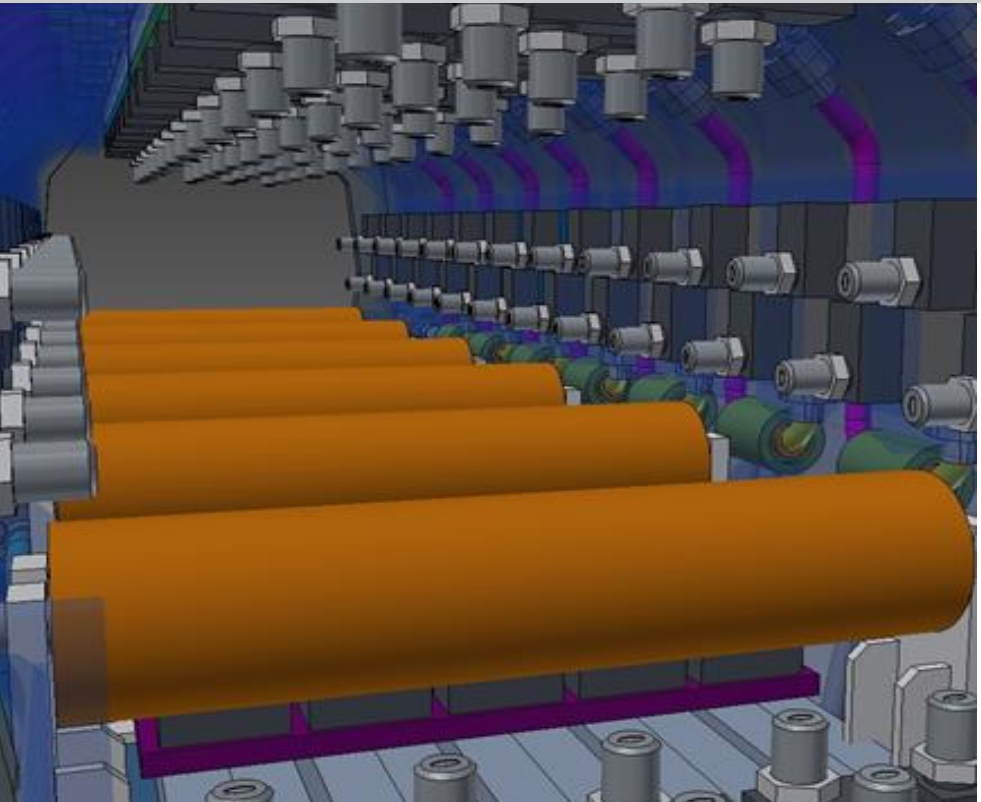


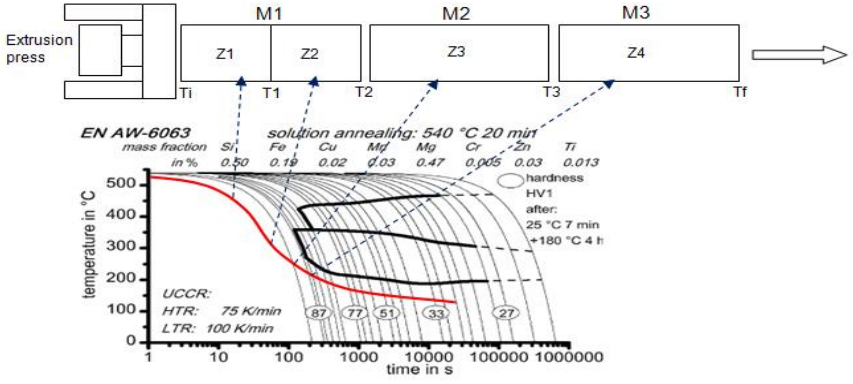
RAPID RE-HEATING NEARLY ZERO LOSSES

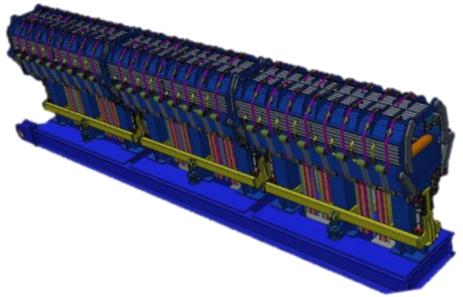




MODULAR AIR-MIST COOLING EXTENSIVE COOLING CONTROL

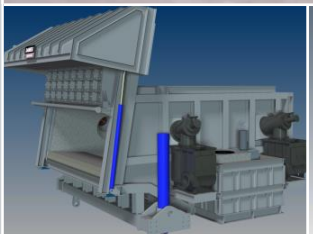


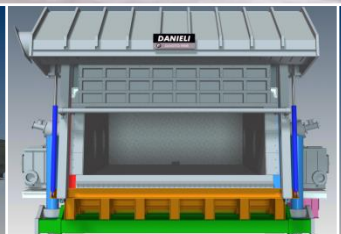


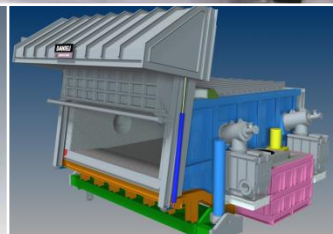


MAIN FEATURES

- Dry-hearth melting for process flexibility with scrap charging.
- A Tilting system for precise metal pouring to suite specific casting requirements.
- Weighting cells and a laser system to monitor the quantity and level of molten aluminium poured into the launder system at the final casting line.
- Proper refractory insulation with high alumina content for minimizing thermal dispersions and maintenance requirements.
- Melting phase with the option of a regenerative burner system to maximize combustion efficiency up to 85%.
- Uniform temperature pattern to achieve higher melt rates and thus avoid hot spots and thermal NOx.
- Fully automated process control to ensure repeatability of process parameters.

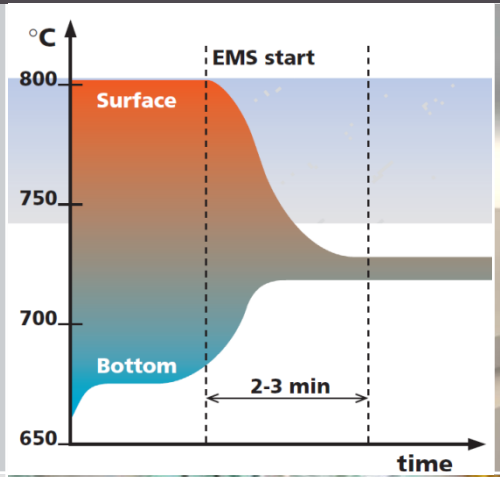


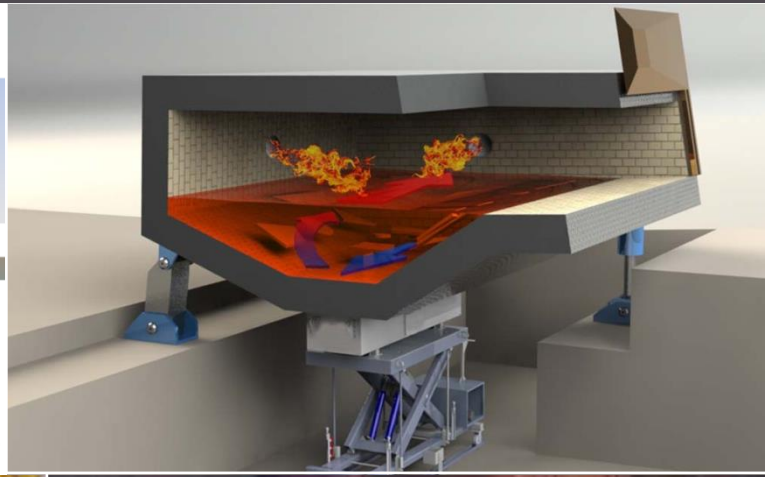




ELECTRO-MAGNETIC STIRRER

- Excellent chemical and temperature homogeneity.
- Minimized dross formation.
- Improving of heat transfer: difference between top and bottom decreases to less than 5° C in about 2-3 minutes after the start of the stirrer.



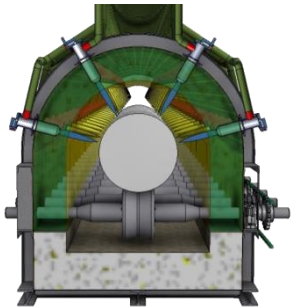


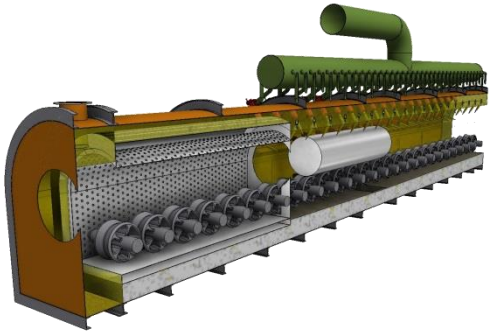
EMP SYSTEM (ELECTRO-MAGNETIC-PUMP)

- Vertical flow patterns: all charged material is instantly submerged in molten metal minimizing the possibility for losses through oxidation.
- Light gauge scrap (chips) and alloy additions can be charged with the furnace door closed, improving cycle time efficiency.

FURNACES PORTFOLIO

- Pusher or pit type reheating and homogenizing furnaces for slabs
- Rapid billet heating furnace
- Homogenizing furnaces with a dedicated cooling chamber for billets
- Heat treatment furnaces for coils and foils
- Solubilization and ageing furnaces for automotive/aerospace components
- Furnaces can be completely integrated with an automatic handling system
- Heat-treating furnaces comply with AMS 2750E standards





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ENERGY SAVING IN EXTRUSION PRESSES
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