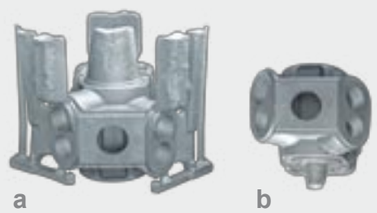
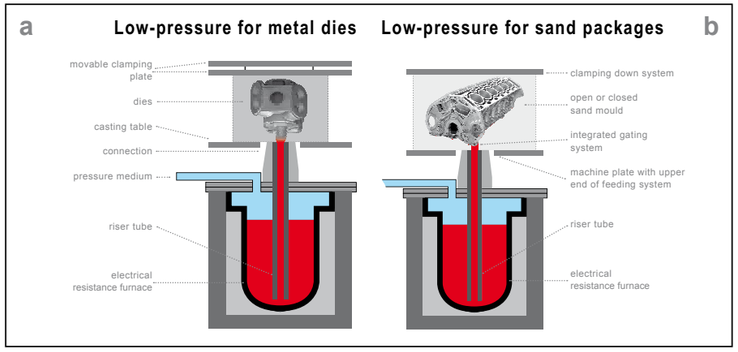
Low pressure die casting machine at Kurtz GmbH



Picture 2: Comparison of gravity casting with low pressure casting: a) Casting made in gravity casting b) Casting made in low pressure casting

Low Pressure Casting

– a process which pays off



Picture 1: Basic principle of low pressure casting: a) low pressure die casting; b) low pressure sand casting

Low Pressure Casting Compared to Gravity Casting

Compared to gravity casting, low pressure casting offers following advantages: In low pressure casting, the metal within the furnace is pressed through the riser tube into the mould by pressure which works on the metal surface (picture 1).This form of mould filling is the most important difference to gravity and tiltabe casting. The process of mould filling proceeds absolutely controlled. This results in a low-turbulence or even turbulence-free mould filling.

The metal within the furnace is in a closed vessel under protected atmosphere. As a result, the melting absorbs less hydrogen and other impurities and the formation of oxide films is reduced. This is the basis for good melting quality.

Unlike in gravity casting, the metal surface is not continuously interrupted by re-dosing in low pressure as the melting is removed through the riser tube under the metal surface. The result is again clean metal.

Especially process sections like the filling of the mould are repeatable executed directly by the machine and therefore depend no longer on the day's form of the "foundryman with the ladle". Moreover, operator errors can be minimized by automated process.

One of the major advantages of low pressure casting is the smaller gating system compared to gravity casting. Feeders are normally not necessary (head feeders only in the minority of cases) which reduces the cycle material. In low pressure casting, cycle material is 5 % to 20 % of casting weight whereas in gravity casting it can be up to 100 %. Less gating material also means that costs for cleaning, trimming and melting-down can be reduced significantly. Costs for cleaning are mainly personnel costs, especially for jobbing foundries with small quantities for which automated cleaning or press punching is not profitable at all. Considering increasing energy costs, which means EURO / kg melting, each kilogram of unnecessary melting should be avoided.

Example (picture 2): Producing 10,000 parts / year and saving 9 kg / part of cycle material saves 90,000 kg aluminium / year (plus approx. 7 % melting loss =96,300 kg). Based on melting costs of 0,35 EURO / kg on average, this means a reduction of costs by 33,705 EURO / year.

Considering these advantages, the higher invest in the machine concept is amortised and profitable within a short time due to above mentioned reasons. Compared to other casting processes, low pressure casting is more than just an alternative.

In summary, gravity casting has definitely still its merit and is surely the more economic process for certain parts. Even if the machine invest is higher at first, low pressure casting is also interesting for jobbing foundries due to the casting quality that can be achieved as well as the savings regarding cycle material and costs for cleaning.

Considering above mentioned explanations, the higher invest pays off very soon and low pressure casting is the more profitable process compared to gravity casting. Nevertheless, it is often not possible to choose between low pressure and gravity casting as only low pressure comes into question due to defined quality requirements. A lot of foundrymen offer low pressure casting also as an alternative to their actual production process to enlarge their product range.

Low Pressure Casting Compared to Counter Pressure Casting

Counter pressure casting is an „old" process which was developed to cast armour wheels in Eastern Europe in the 60s / 70s. A long time, this process was not found on the market anymore and is now published again. Counter pressure casting is similar to low pressure casting and also the mechanical properties which can be achieved are comparable. Definitely, low pressure casting can stand comparison with counter pressure casting. However, counter pressure casting is operating with two pressure chambers. Both chambers, furnace as chamber 1 and another pressure chamber around the tooling as chamber 2, are pressurized at the same time. Working pressure is approx. 3 to 4 bar. The furnace pressure itself is increased again by approx. 1 bar so that the mould is filled. Consequently, the mould is filled with a pressure difference of approx. 1 bar which corresponds to low pressure casting.

In counter pressure casting, the working pressure is three to four times higher than in low pressure casting and the machine operates with two pressures chambers which have to be filled with air. Therefore, current costs for air consumption are far higher. Moreover, the tooling costs are greater as the die has to be designed differently. As core pulls have to be inside the second pressure chamber, it is not or only with huge efforts possible to install core pulls at the machine. Therefore, it is necessary to integrate them into the die which increases the costs for the tooling and makes the maintenance more extensive. Due to safety regulations, especially for pressure tanks, the invest in counter pressure casting machines is significantly higher compared to low pressure casting machines, provided that the machine manufacturer follows these regulations.

Important Factors for „Good Casting"

Besides mould concept and cooling a reproducible process sequence is an important factor for quality and cycle time. The heart of the KURTZ low pressure die casting machine is the low pressure control unit developed by KURTZ. It offers great advantages and reliability compared to other products. The low pressure control unit operates with proportional technology and achieves accuracies of ±1 mbar.

The accuracy has been proved by an operating data control function recorded by the machine control unit and external measuring devices.

Results:

No.	L_0 in mm	Elastic modulus in kN/mm²	$R_{p0,2}$ in N/mm²	R_m in N/mm²	F_{max1} in N	A (korr) in %	A in %	Fracture
1	30.81	72.7	184.24	339.46	9985.88	17.39	17.39	nahe MF
2	30.47	96.4	183.57	339.89	10 063.85	18.34	18.89	nahe MF

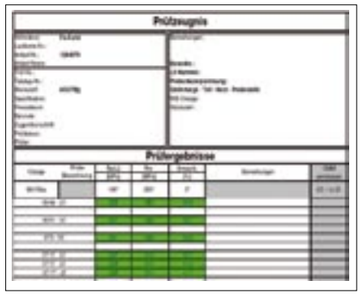
Statistics:

Series n = 2	Elastic modulus in kN/mm²	$R_{p0,2}$ in N/mm²	R_m in N/mm²	A (korr) in %	L_0 in mm	A in %	F_{max1} in N
x	84.6	183.91	339.86	17.86	30.54	18.04	10 024.86
s	16.8	0.47	0.30	0.67	0.10	0.92	55.13
v	19.87	0.26	0.09	3.77	0.33	5.12	0.55

Table 2: Results of the strength test for a coupling plate for trucks made of Al Cu4Ti T6 in low pressure casting; wall thicknesses 12 to 30 mm; weight per piece 14 kg

Characteristic values	Age hardening 160 °C/4 h	Age hardening 160 °C/5 h	Age hardening 170 °C/4 h	Annealing 535 °C/6 h
0.2 %-Yield strength $R_{p0,2}$ in Mpa	255	245	267	280
Tensile strength R_m in MPa	290	292	304	340
Elongation after fracture A5 in %	8.3	10.6	5.6	10.0

Table 1: Mechanical properties of a wheel carrier made of Al Si 7MG (0,3) T6 cast in low pressure casting after different heat treatments [Al Si7Mg(0,3)T6 – 7,3 % (Mass percentage) Si; 0,103 % Fe; 0,001 % Cu; 0,005 % Mn; 0,33 % Mg; 0,005 % Zn; 0,0002 % Na; 0,12 % Ti; 0,003 % Ni]



Picture 3: Test certificate of a transmission suspension made in low pressure casting (flat bar tension specimen, wall thicknesses 4 to 12 mm, weight per piece 2,1 to 3,8 kg)

Further factors for successful low pressure casting are cooling/cooling control, casting concepts, moulds/mould concepts, melting preparation/quality and reproducible machine processes. KURTZ has a long and varied experience in all these fields and can offer a wide range of possibilities.

Results and Valuation

The data shown in table 1 have been investigated on a wheel carrier produced in low pressure casting. The trials were made with different heat treatments to check the effects on the mechanical properties. Two days for casting trials had to be sufficient for KURTZ to cast the part in low pressure casting successfully. The part produced by low pressure casting has passed the pulsating fatigue test promptly. In contrast it was not achieved with counter pressure casting.

Picture 3 shows a test certificate indicating the strength of a transmission suspension manufactured in low pressure casting. The data were investigated by flat bar tension specimen with a cross section of 4 x 10 mm (thus the most unfavourable test bar)

With investigations of the strength of coupling pates for trucks (table 2) produced in low pressure casting the main attention was paid to the expansion to be achieved.

The lateral parts of the casting were bent by 45 °C without breaking. As a conclusion it can be said that the casting quality achieved in low pressure casting can be compared to counter pressure casting. The efficiency is a considerable advantage of low pressure die casting thanks to the lower investment costs and the somewhat higher costs arising with counter pressure casting.

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