A new established extrusion press sets new remarkable benchmarks. Radical new approaches are reducing the hydraulic drive of the extrusion press, minimising energy consumption, increasing the productivity and implicate an unmatched dynamic to the extrusion process. While developments in earlier years were focussing mainly on optimisation of the extrusion technology, these recent development steps are targeting to increase energy efficiency and productivity. A hybrid drive concept with highly dynamic servo drives for fast movements and a new unique hydraulic design combined with the novel HMI-system with joystick controls are the highlights of the new press. An eye-catching integrated housing, which includes also a safety concept, brings contemporary industrial design into the press shop while PICOS-TO-GO, which allows for online-monitoring of the extrusion press by mobile devices, comes along with a smart platform-independent browser based application.

Introduction

At the beginning of the last century, when the rise of the new material aluminum started, the industrial application of extrusion presses for the production of bars, wire and profiles increased rapidly. The presses at that time had a water-hydraulic drive system, some of them only three or even two tie rods, a longitudinal die slide with external discard shear, and a venture some heating system for the container but in general they were looking and operating like today’s extrusion presses. Even the front loading technology, today the standard for state-of-the-art aluminum extrusion presses was already applied before World War II.

In the following decades extrusion presses have been improved by pre-stressed press frames, oil-hydraulic drives, first rotary die changers later die cassette shifting, multiple zone container resistance heating etc. but in principle they still were fully hydraulic operated machines. The real development in the field of extrusion was more focused on metal treatment, die design & technology, quenching, finishing or process control. Now-a-days however the goals of the recent development steps are improvement of energy efficiency and productivity.

Today, the working principle of an extrusion press is as follows: the billet is front-loaded and clamped between extrusion stem and die stack. The press force is generated by a main cylinder in combination with the side cylinders, all auxiliary movements on and off the press is mostly
performed by hydraulic cylinders. Design and dimensioning of the hydraulic drives is determined by the press force, press speed, oil supply to the auxiliary cylinders and the shortest possible dead-cycle-time between the end of one extrusion and the start of the next. The hydraulic tank is located above the main cylinder and connected to via pipe work and the prefill valve. The valve blocks are mounted on the tank, the pump drive is typically installed on floor behind the press. This almost all-hydraulic-powered press design results finally in large hydraulic systems with high pump powers sometimes even with additional accumulator stations, which is finally reflected in correspondingly high power consumption. However, the new developed HybrEx® press is different.

New Approaches to Improve Energy Efficiency

When the extrusion press team of SMS started the project to develop a new generation of extrusion presses the engineers were mainly targeting on power savings. The company's internal marking of energy efficient products with the ecoplants®-label for reaching a significantly improved utilisation of resources and thus sustainability and cost savings, was the ambition.

Fig. 1: Extrusion Press HybrEx®25 MN (8 inch), 1,300 mm Billet Length

The new extrusion press generation is based on the idea of replacing the hydraulics for those movements where speed is more important than power with high-dynamic electric servo drives. Hydraulic power is unrivalled for the generation of the high extrusion forces thanks to its energy density. Around the extrusion press, however, there are a large number of movements where the first priority is speed. Fast auxiliary movements however require a high oil flow rate in order to achieve the intended reduction in the non-productive times. Example: In order to move a hydraulically operated billet loader quickly when loading the billet, this movement is performed at a speed of more than 1000 mm/s and a correspondingly high oil flow rate. In the new developed press, such ancillary movements are no longer performed by hydraulic cylinders; now dynamic electric servo drives are used which not only achieve twice the speed, but also allow significantly more precise positioning.

With the new drive concept, several movements are now performed by electric servo motors:

1. The side cylinders which on conventional presses are responsible for the fast forward and return movements of the main cylinder are replaced by high-speed servo drives. In conjunction with the proven low-friction linear guides, this ensures optimum guide precision with maximum dynamics.

2. The container shifting cylinders which move the container quickly and also generate the sealing and stripping forces are also replaced by dynamic servo drives.

3. The side table of the extrusion press is also moved by electric servo motors.

4. The billet loader as already mentioned is all-electric, i.e. apart from the forward and return movements, the telescoping of the loading grippers and their opening/closing movement are also performed by electric servo drives.

Wherever high forces need to be applied the press is still using the unmatched force density of hydraulic cylinders: e.g. extrusion stroke and discard shearing.

This hybrid electro-hydraulic drive concept is the background of the new press name HybrEx®.

Fig. 2 : Dynamic Servo Drive for Stem and Container Movement

The installed electric motors have been especially designed as main drives in production machines and machine tools. They are widely used for mechanical and plant engineering applications and are characterized by excellent performance properties, high compactness and reduced noise emission. They are forced air-cooled and the drives on the container housing have an additional heat shield in order to be protected against the thermal radiation of the container.

Complete New Hydraulic System

Yet soon after starting the new press project the idea of further reducing of the hydraulic functions and components led to the innovative design of the press cylinder with integrated reservoir tank. The principle to absorb the oil volume from the reversing press cylinder into a reservoir tank directly behind the press cylinder gives the press not only a completely new appearance, but also has a significant impact on the design size of the hydraulic tank: A major role in determining the tank capacity is played by the "surge volume". That is the oil volume which is pushed in a very short time from the main cylinder to the tank via the prefill valve at each extrusion end/ opening of the press– i.e. during the dead-cycle-time. On a 25 MN standard frontloading press, that can be as much as approx. 1500 litres within just 1.5 seconds. In order to prevent turbulence and foaming of the oil, a correspondingly large tank volume of approx. 5 times the surge volume has been required to date. The tank size necessary on conventional extrusion presses is therefore not only a cost factor, but often also a challenge regarding the height at the installation location.
In order to avoid all this, the press is equipped not only with this integrated reservoir tank, but also with the innovative OXiStop® tank technology of HYDAC. Its features are an air-tight sealed tank with diaphragm technology and degassing device. With this technique the air content in the oil is reduced from 10% down to 1% which is significant for the lifetime of pumps and valves. The surge volume and hence also the tank volume can be drastically reduced.

**Fig. 3 :** HYDAC OXiStop® Diaphragm Tank

An important detail of the extrusion press is also the integrated prefill valve. This design detail replaces the conventional valve technology previously used at this point. The large opening cross-section of the valve reduces the flow resistance and thus minimises losses and oil heating.

**Fig. 4 :** Press Cylinder with Integrated Reservoir Tank and Prefill Valve

**New Type of Pumps for Better Efficiency**

Variable-displacement axial-piston pumps are used today for the hydraulic drive on extrusion presses. They are proven and really have only one, but depending on the method of operation of the press a crucial disadvantage: With lower delivery volumes of the pump, for example, at low stem speeds, their efficiency is reduced significantly. Higher efficiency losses are the result. The efficiency of the internal-gear-pumps with variable-frequency drive used on the new press, on the other hand, changes only marginally over a wide speed range. Internal gear pumps are very robust and have only two moving parts, the pinion gear and the ring gear and their noise emission is significantly lower.

**Fig. 5 :** Comparison of Efficiency : Internal Gear Pump Vs. Axial Piston Pump

The common practice to date of allowing pumps, which are not required to run idle also means a waste of energy and could not be used for a pioneering concept. For this reason, only the pumps are switched on that are necessary for the required stem speed. Pumps that are switched off consume no power and are switched on in time when a larger oil volume is required.

A comparison with other extrusion presses of different technical condition shows Fig. 6. The overall power savings sum up to 32% - 50%, however depending on extrusion speed and production mix.

**Analysis of Energy Consumption of Three 25 MN Extrusion Presses (Germany, Construction Profiles)**

<table>
<thead>
<tr>
<th>Pressentyp</th>
<th>Stem Speed</th>
<th>Extrusion</th>
<th>Speed Extr. Ratio</th>
<th>Energy Consumption / t</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 MN Standard Press (25 Years Old)</td>
<td>6 – 9 mm/s</td>
<td>20 – 50 m/min</td>
<td>60 – 100</td>
<td>155 kWh/t</td>
</tr>
<tr>
<td>25 MN Front Loading Press (3 Years Old)</td>
<td>6 – 9 mm/s</td>
<td>15 – 50 m/min</td>
<td>40 – 100</td>
<td>115 kWh/t</td>
</tr>
<tr>
<td>HybrEx 25 MN</td>
<td>6 – 9 mm/s</td>
<td>15 – 50 m/min</td>
<td>40 – 100</td>
<td>78 kWh/t</td>
</tr>
</tbody>
</table>

**Fig. 6 :** Energy Saving through Power-on-command Drives During the Extrusion Cycle
So finally the goal to fulfill the benchmarks for the ecoplants®-label was reached.

**Reduced Space Requirements**

The compact hydraulic power unit together with the downscaled tank facilitates a very dense arrangement and small footprint of the press plant. Savings are up to 5 m (16.5 ft) in length and 1 m (3.3 ft) in height. The power pack with the integrated small OXiStop-tank is placed behind or on the side of the press. Also an arrangement in the cellar or a separate room is possible. Due to the low noise emissions of the internal gear pumps and the reduced hydraulic actuated motions of the press often a sound enclosure will be needless.

**Conventional Extrusion Press Concept**

![Conventional Extrusion Press Concept](image)

**HybrEx Concept**

![HybrEx Concept](image)

**Fig. 7 : Ecological and Economic Benefits of the Hybrex®concept**

**Ecological benefits:**
- Reduced oil volume
- Reduced energy consumption
- Reduced cooling capacity

**Economic benefits:**
- Energy cost savings *
- Resulting savings 370,000 kWh/t/a *

* based on comparison of actual consumption data of a 25 MN Frontloading press and the Hybrex®

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**Fig. 8 : Comparison of Standard Press Layout Vs. Hybrex® Layout**

An award-winning design with a modern shaped integrated housing, which includes a safety concept for the billet loader and side table area as well as for the backside of the press, brings contemporary industrial design into the extrusion plant. Service openings allow for access to the maintenance areas of the press.

**Fig. 9 : Integrated Housing**

**Innovative Human-machine Interface for an Innovative Extrusion Press**

The control desk of the press is following a new operating concept where movements are actuated via two joysticks. The function assignment to the joysticks can be selected and modified by the operator. The revised HMI-system comes with an extra wide touch screen and push buttons are reduced to safety relevant functions only.

**Fig. 10 : Joystick Operated Control Desk**

The application PICOS-TO-GO allows for online-monitoring of the extrusion press with mobile devices, it comes along with a clever platform-independent browser based application and can be used on every smartphone or tablet without installing any software or app. It informs about energy efficiency, actual status of function groups like e.g. filter-cooling unit, container heating and can also provide data of runout and log heater.

**Fig. 11 : Web-browser-based–application for Online Monitoring on Mobile Devices**
Conclusions

- Numerous benefits from a radically changed concept
- Hydraulic power basically reduced to main press cylinder, discard shear and cassette shifting
- Other movements with high-speed, high-precision servo motors
- Innovative tank technology with integrated degassing unit and significantly smaller tank volume
- Innovative design of the press cylinder for reduced oil surge volume
- Internal gear pumps for more efficiency and less noise
- Significant energy savings
- Lower overall height and smaller footprint
- Modern design with integrated safety concept
- New HMI-system with application for mobile devices

The strict implementation of new approaches in the development of a new press generation resulted in an extrusion press that is regarded at SMS also as carrier of technology for further innovations in the future. Optimised discard shear, faster tool changing, a nearly deflection-free counterplaten design are just a few examples of future options.