Historical Development of the Automated Filter Press

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Introduction

In the mining industry, the Automated Filter Press (AFP) has gained widespread usage for recovery of metal-bearing solutions from leached ore and dewatering concentrates and tailings. This narrative provides an insight to the development of the filtration process as it evolved from ancient times through the industrial revolution and modernization of the design. The modern AFP has grown in size and durability to provide the capacity needed for large scale applications. Additionally, efficient modern manufacturing techniques and increased production have reduced the capital cost, making the AFP a viable alternative approach to a myriad of traditional dewatering applications.

Historical Development of the Plate and Frame Filter Press

Filtration in itself has a long and rich history with mankind dating back millennia to several cultures spanning from southwest China to the Middle East and later to the Roman Empire.

While not documented in western history, the Shang Dynasty developed tea production from camellia as early as 1600 BC and likely extracted camellia oil with a wooden filter press (Ref. 1) Camellia oil is still used today by 27% of China for cooking oil. During the 18th Dynasty in Egypt (1543 – 1292 BC), a sack press squeezed by a giant tourniquet was used to extract juice from grapes (Ref. 2). During the Roman Empire (100 BC- 400 AD), Cato the Elder described wooden presses used in the Roman wine industry (Ref 3). These early applications of filtration for cooking oil and wine production indicate that the technology was in widespread use by the first century AD.

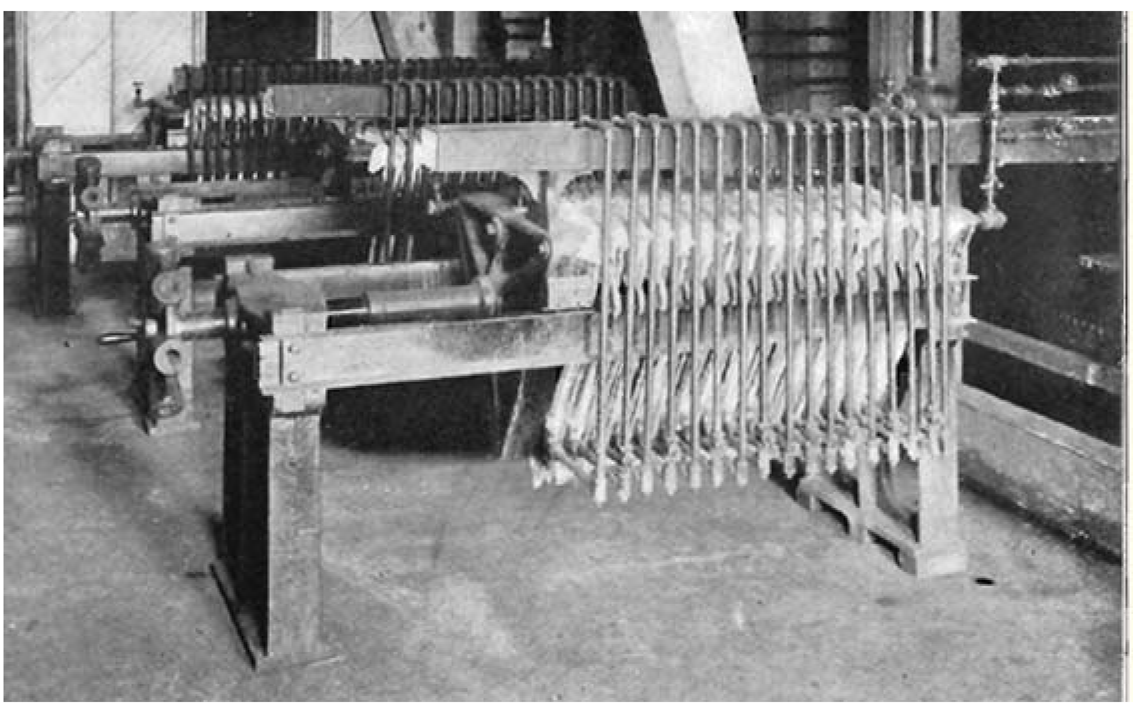
Not much improvement to the design of the wooden press transpired until the industrial revolution of the 18th century. The first form of a mechanical filter press was invented in the United Kingdom in 1853 and was used for obtaining seed oil through the use of pressure cells (Ref. 4). Although not much information is available on the early British press, it was likely the forerunner to the Johnson Press. The Johnson Press filter press was the first steel plate and frame filter press and was soon destined to be in great demand for food processing and industrial applications (Ref. 5).

Innovations in the mining industry greatly increased the demand for a more efficient filter press. In 1783, Scheele discovers that gold dissolves in cyanide; in the 1880's Beilby, develops a process to produce commercial quantities of cyanide. In 1889, the first application of cyanide for gold recovery was employed at the Crown Mine, Karangahalke, New Zealand. By 1892 there were six plants operating with cyanide at New Zealand Ohinemuri Goldfield (Ref. 6).

Two inventors furthered the development of the gold recovery process into what we know today as the Merrill Crowe process. First, Charles Washington Merrill (1869 – 1958) invented the first half of the Merrill Crowe process for the precipitation of gold from cyanide solution using zinc shavings around 1900 while working for the Homestake mining in Lead, South Dakota. Second, James B. Crowe added in the vacuum tower in 1913. The Merrill Crowe process quickly evolved to use zinc dust rather than zinc shavings, and the plate and frame filter press was employed to recover the zinc dust (gold precipitate) from the gold cyanide solutions.

The Dorr Company (founded in 1865) and Oliver United Filter (founded in 1915) merged to become Dorr-Oliver in 1931. Eastern Iron and Metal Corporation (founded in 1884) was renamed "EIMCO Process Equipment Company" in the 1930's, and Dorr-Oliver and Eimco were merged to form Dorr-Oliver Eimco in 2002 (Ref. 7). The Eimco plate and frame filter press enjoyed widespread use in the gold industry for well over a century and is still in use in older plants where conversion to AFP was never made.

Figure 1. Early Design Plate and Frame Filter (Technomine)



DEVELOPMENT OF THE AUTOMATED FILTER PRESS

In 1959, K. Kurita and S. Suwa succeeded in developing the world's first automatic horizontal-type filter press to improve the cake removal efficiency and moisture absorption (Ref. 8). Nine years later, the Kurita Company began developing flexible diaphragms to decrease moisture in filter cakes which is the modern day equivalent of the AFP in widespread use today. In this configuration, plates are inflated with air or water to remove additional moisture. The AFP employs automated operation utilizing Programmable Logic Controlled (PLC) filtration cycle, cake compression, cake discharge and filter-cloth washing. These features improve production, service, and uptime in many industrial applications. Nowadays, the technology is used in:

- Sand, gravel and aggregates
- Industrial minerals and metals including copper, gold silver, phosphates and magnetite
- Municipal waste (biosolids) dewatering
- Ready-mix concrete water recovery
- Fine coal dewatering
- Frac sand and proppants
- Fly ash dewatering for dry impoundment

Innovation and new applications, along with more widespread acceptance of the AFP in traditional applications, has generated increased demand for AFP units. Worldwide production of filter presses is estimated at over twenty thousand units in 2015 (Ref. 8). Increased production coupled with automated manufacturing has lowered the cost of the AFP. While exact numbers cannot be put to a volume/cost relationship, a classical relationship exists and the cost of filtration has been steadily falling as production increased. Growth in demand can also be attributed to enhanced production features of the AFP:

- High capacity (up to 360 dry tons per hour per cycle)
- Extremely low moisture content (15% or less)
- Low or no flocculant, compared to traditional belt presses
- Low power consumption
- Completely automated
- Low maintenance cost
- Automated filter media washing system
- Precision manufacturing
- Proprietary processing algorithms
- Minimum wear/replacement parts

Jingjin Environmental Protection, located in the Shandong province of China, is the largest AFP manufacturing company in the world providing over ten thousand AFP units per annum, approximately half of the annual world production. A

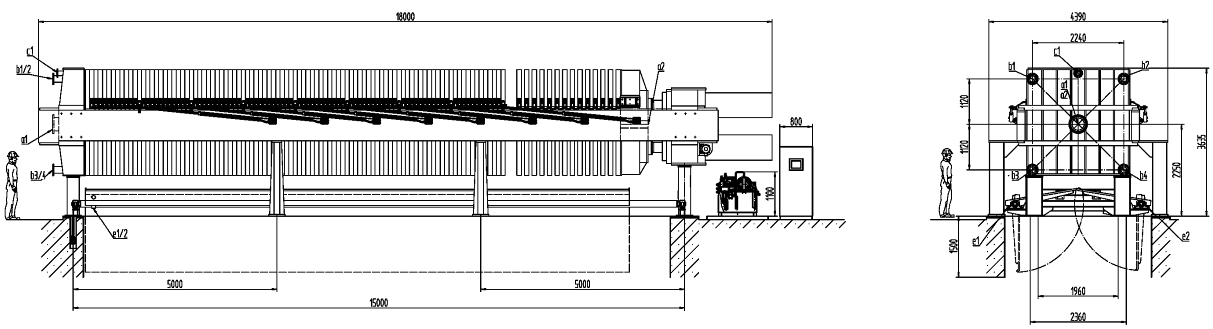
Common sizes provided by Jingjin are shown in Table 1 below.

Table 1: Common AFP Sizes and Capacities

Model	Number of Chambers	Filter Area (meters^2)	Cake thickness (mm)	Approx. overall dimensions (LxWx , meters)	Membrane pressure (MPa)	Cycles (per hour)	Disposal capacity (tons/hour)
2500x2600	50-110	470-1040	40	18-23 x 4.3 x 3.6	2	3-5	60-450
2000x2000	44-184	300-700	45	11-19 x 3.7 x 3.2	2	3-5	50-368
1500x1500	26-64	100-250	45	8-13 x 3.1 x 2.9	2	3-5	10-70
1000x1000	28-52	40-80	40	7-9 x 1.7 x 1.8	2	4-8	4.2-12
800x800	10-40	10-40	30	5.8-4 x 1.5 x 1.9	2	4-10	0.6-1.8

Actual filtration area and volume varies with the of number of plates selected for the application. An example of a 2000 millimeter (mm) by 2000 mm (plate size) press is shown in Fig 1, note the size of the man to the left of each figure.

Fig 1: Jingjin Environmental 2500 by 2600 mm membrane filter press with 100 plates.



Like many technologies from ancient times, change began slowly but has now reached exponential growth and capacity.

CONCLUSION

The AFP is the continuation of millennia of improvement to the process of filtration. Innovation in design and manufacture along with increases in unit capacity and lower costs has moved the AFP onto an equal basis with traditional methods of dewatering solids. Aspects of the AFP such as water conservation and risk mitigation of catastrophic failure will continue to be ever more important in the study and planning of new operations.

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