DEWATERING OF METAL FINISHING PLANT WASTES WITH THE USE OF FILTER PRESSES

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Almost all metal finishing plants generate varied forms of metal wastes which if not reclaimed or recycled in-house, must be converted to a particulate form for transfer off-site.

Following is a partial list of some of the industries that are currently generating these types of wastes:

Plating shops
Galvanizers
Printed circuit board producers
Steel producers—both mill and finished products
Foundries
Phosphatizers
Aluminum and steel can plants
Vibratory, burnishing and deburring operations
Electro-chemical and electro-discharged machiners (ECM & EDM)
Electronic component producers
Anodizers
Battery producers
Aluminum extruders
Aluminum mills

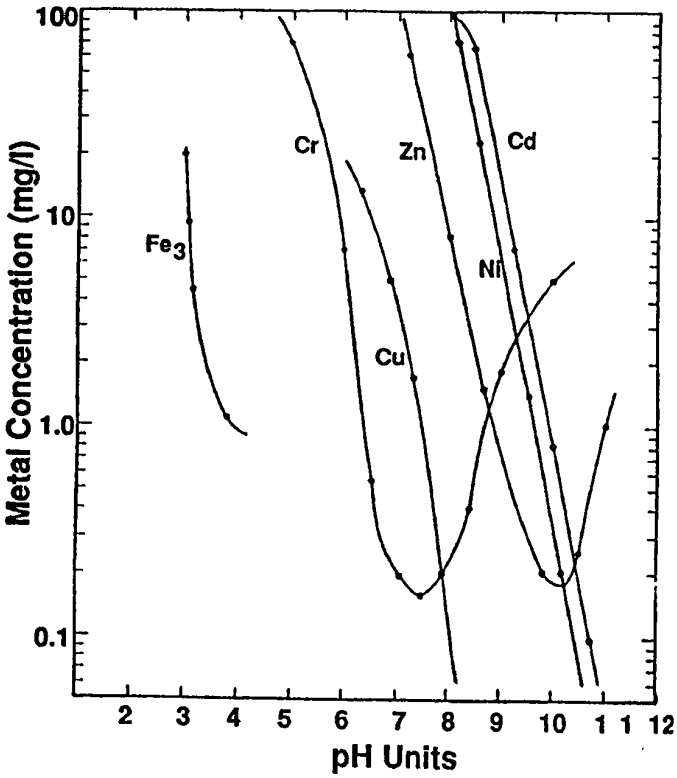


FIGURE 1. Precipitation of metal salts versus pH.

Our market research indicates that the above list totals over 18,500 plants in the United States alone which are generating a total of approximately 15,000 cubic yards per day of partially dewatered material in cake or slurry form for off-site removal.

The driving forces that cause these industries to even attempt any waste treatment are the Federal hazard waste regulations such as RCRA, water discharge regulations of the governing municipalities, concern for in-house worker safety, and disposal costs.

Most, but not all, of these wastes are metals in a dissolved liquid borne form that must be converted to a particulate form to enable separation from their carrying liquids. This is usually accomplished with a pH adjustment and precipitation procedure using the addition of such chemicals as sodium hydroxide, calcium oxide, magnesium hydroxide, sulfides, or various acids. Different metals have different solubilities, as illustrated in Fig. 1, and require varying treatment procedures to insure removal. This is particularly difficult with waste streams containing several metals, and they might require several separate precipitation steps.

This pH adjustment will normally result in the formation of a metal hydroxide which in turn, will eventually separate and settle with a little coaxing. The addition of coagulants and/or polymers will aid in this settling and will result in a thickened slurry amenable to further dewatering.

The first method used was the drying bed. This worked in warmer climates but did produce leachate problems and could eventually turn the bed into a hazardous landfill. Another method used was the simple settle, decant, settle, decant, and on until only a thickened sludge of approximately 2-5% by weight solids remained. This generated a haulable material for off-site disposal, but the volume reduction was only 5 to 1.

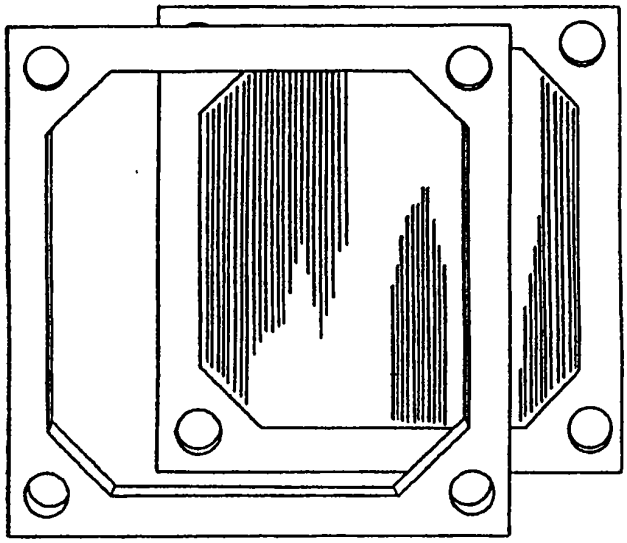
As regulations became more stringent and disposal costs continued to increase, these procedures became no longer viable and more efficient methods of increasing the solids content of disposed materials were sought.

Next tried, and still being used by some small volume generators, were solid bowl scoop discharge centrifuges. These, at best, yielded 10-15% solids and an approximate 10 to 1 volume reduction. Though eliminating the labor involved with drying beds and decanting, the solids content is still too low.

Another type of equipment being used is vacuum filters of both the belt and rotary types. In most cases, these do require precoating of the media with some sort of filter aid such as diatomaceous earth, perlite, cellulose, or fly ash. In extreme cases, some sludges also require the addition of one of the aforementioned filter aids as a bodyfeed. This does add to the final cake volume which in turn increases disposal costs. While the addition of aids can result in fairly high dry solids

cakes–approximately 25-30%–the economics of buying the aid and paying for hauling into and out of the plant usually cause the user to seek a more efficient method.

The method now most commonly used is pressure filtration in filter presses. While the generic name "plate and frame" press is still widely used, most all presses are now equipped with filter plates of newer, more efficient designs than the "good old" flush plate and separate hollow centered frame. Please see Figs. 2,3, and 4 that illustrate P&Fs, the newer recessed chamber plates and gasketed recessed chamber plates.



IGURE. 2. Flush plate and frame.

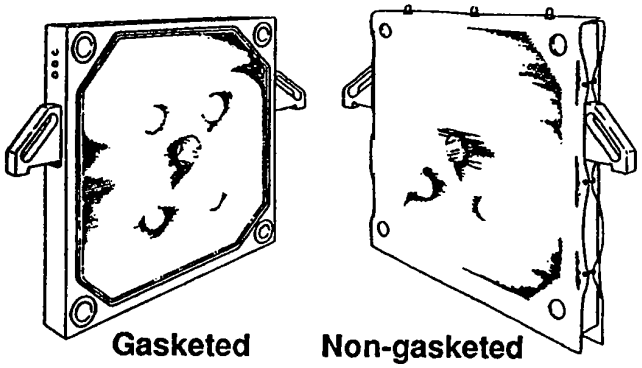


FIGURE 3. Chamber plates.

The use of newer design plates has allowed the filter press to become the most widely used type of waste filtration equipment in the metals industries. This is due to several factors, such as:

- High energy efficiency
- Low maintenance cost
- Simplicity of operation
- Reduced pretreatment chemical costs
- High degree of flexibility
- Most importantly–the highest dry solids content filter cake of most types of commonly used filtration

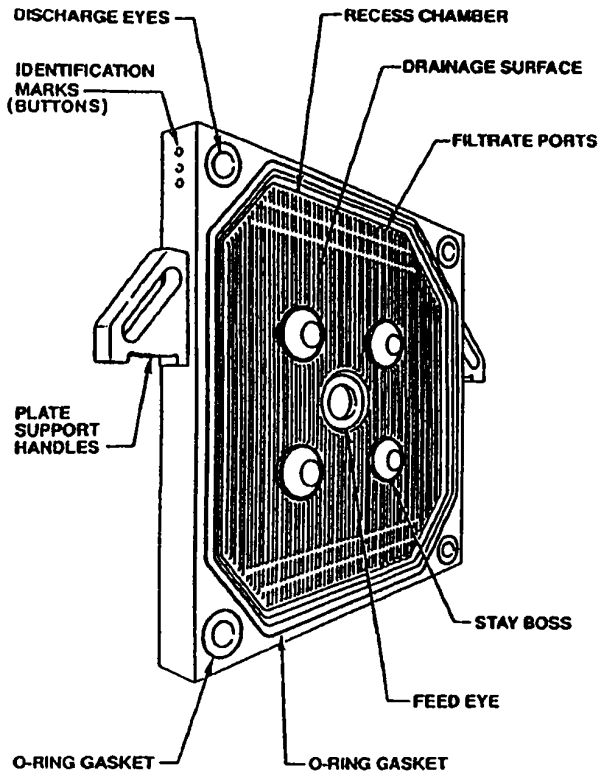


FIGURE. 4. Gasketed chamber plate.

equipment. Cake solids content for most metal hydroxides range from 30% up to 75% for a volume reduction of 25 to 1 and up.

The early applications of filter presses commonly used wooden, cast iron or rubber plates and frames. These types of elements limited filtration feed pressures to 100 PSI or, in the case of wood, as low as 60 PSI. This, of course, did limit the efficiency of the presses from both the throughput flow rate and cake solids yield standpoint. The introduction and utilization of polypropylene plates and frames approximately 20 years ago did improve efficiency somewhat, but it took the development 15 years ago and the use of recessed chamber plate, particularly in the gasketed configuration, to bring the filter press out of the dark ages and into a form that was amenable to modern day plant operations.

Whereas the old wooden, rubber and cast iron plates would leak profusely during feeding, the newer type plates drastically reduced this leakage and, in the case of gasketed plates, almost totally eliminated it.

Most of the existing waste filter presses in the metals industry are of the 100 PSI maximum feed pressure design, but an increasing number is being installed of the higher 225 PSI pressure design. The higher feed pressures do, in some cases, allow for quicker cycle times and higher cake solids content. Testing, though, has shown that on certain types of metal hydroxide, the higher pressure does not always yield enough of an increase in cake solids content to justify both the higher initial capital cost of approximately 30% and higher operating expenses.

The next major development in press technology was the membrane or diaphragm plate. This uses a flexible, but impermeable drainage surface, which in most design, is

affixed to the periphery of the drainage surface. See Fig. 5. By using membranes, you actually cut back on your terminal feed pumping pressure and optimize your feed cycle times to use the most efficient flow rate portion on the curve. See Fig. 6.

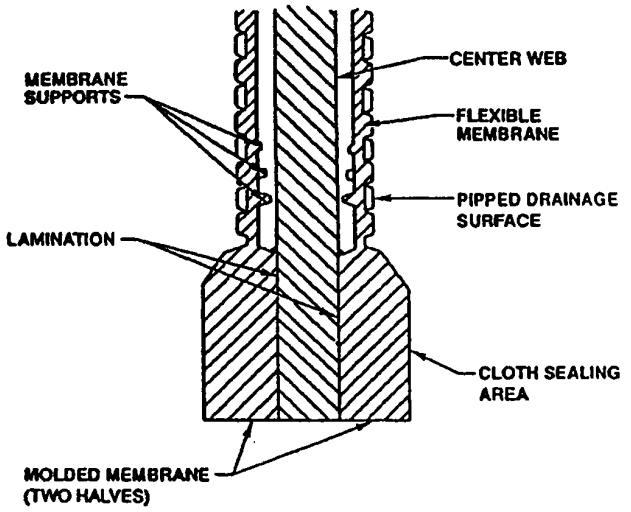


FIGURE 5. Membrane chamber plate cross section.

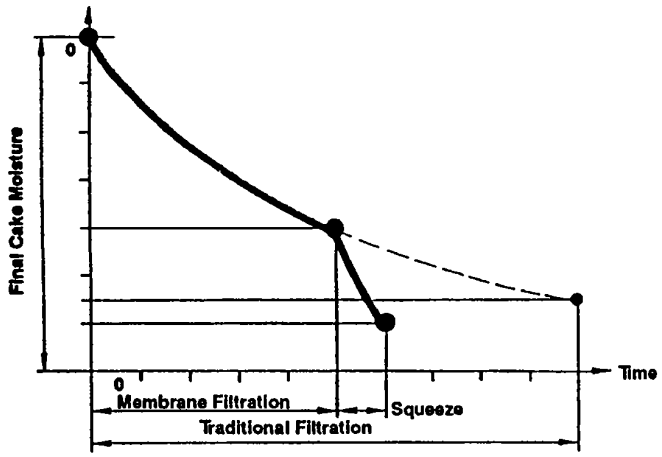


FIGURE 6. Filtration time vs. cake moisture content. Illustrating membrane plate advantage in cycle time reduction.

After completion of the feed cycle, the membranes are inflated with compressed air or water at pressures up to 225 PSI and the cakes are mechanically dewatered to a higher degree in the chambers. In almost all cases of compressible cakes, the 225 PSI squeeze pressure has proven to be more efficient than 225 PSI feed pumping pressures. We are in the midst of a long range test program using a 630 mm membrane plate pilot test press to ascertain which metal hydroxide sludges will benefit most from the use of membrane plate technology.

The on-going mechanical development of presses and the resultant high degree of automation has removed the onus that presses always carried of being labor intensive "crude" pieces of machinery. Even with their mechanical sophistication, they are still less complex and require less maintenance than almost all other types of high solids yielding dewatering equipment. There are several brands of filter presses now available that are labeled as fully automatic and requiring little or not operator attendance.

We believe that the one development that has most helped presses to attain automatic cake discharge is the ever broadening array of filter cloths available. The materials used in construction, the weave, structures, and surface finishes have all added up to presses that will, in many cases, automatically release the cakes upon plate opening. Each application, though, must be thoroughly analyzed to make sure that the cloth chosen gives not only good cake release qualities, but also suits the process requirement concerning flow rate, clarity, and chemical compatibility.

With the inclusion of microprocessors and PLCs into press controls, you can fully automate almost every aspect of press operation and attain true attendance-free operation. Of course, this does not come without increased capital investment. When weighted against the ever increasing disposal and labor costs, the larger volume waste generators are currently considering and installing new automatic filter presses.

Even with the high dry solids attained with modern presses, there are certain circumstances where the resultant dry content is still just not high enough to suit landfill regulations or requirements of resmelters. The next step required in the process is filter cake drying. These dryers are produced in many forms such as infrared, direct hot air, indirect hot air, hollow flight, and many others. They will normally discharge materials with dry solids content in the range of 60-98%. This will, of course, reduce hauling costs whether they are based on weight or volume, but we know of several instances where landfills have refused to accept materials that are too dry due to supposed dusting problems. This requires the waste treatment plant operators to walk a tightrope and dry the materials as much as possible to keep the hauling costs down but yet not too dry to create a problem.

CONCLUSIONS

While metal finishing wastes are a nationally recognized problem, we are certain that with the use of modern filter press technology along with advance pretreatment steps, reclamation and recycling, we can reduce the problem to a level acceptable to all of us.