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Reduction of Solid Waste from Recycle Mills

(PP97-RE3)

Annual Progress Report to the Georgia Consortium

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July 1997

Overview

Sludge disposal is an expensive necessity in the industry. If sludge is landfilled, a cost of approximately $50/ton is incurred. If 30 tons of sludge are generated daily, then the disposal bill amounts to $500K per year. Alternatively, if 30% solids sludge (which is typical of belt-pressed material) is burned, then the added fuel also works out to about $500K per year. The purpose of this project is to determine whether impulse drying, a technology developed for drying paper can be applied to sludge. In impulse, a hot roll contacts the web, and steam is generated at the roll-web interface. The pressure generated forces out the water as water and not as steam, which realizes substantial energy savings. If the sludge can be taken to 50% solids, then its combustion will be break-even situation. Thus, the technology offers the option of converting a landfill waste to a fuel.

Laboratory studies were conducted on sludge from Riverwood, Macon, GA, Hollingsworth and Voss, Hawkinsville, GA, Georgia-Pacific, Big Island, VA, and the city of Houston, TX. These ranged from purely industrial to purely municipal. The results are described in the attached manuscript, *Impulse Drying Sludge,* which will appear in the journal *Water Research*. Briefly, an additional 10-20 percentage points of water could be removed from the various sludges.

Brief pilot runs were made at IPST with sludge collected from Riverwood, Macon, GA, Hollingsworth and Voss, Hawkinsville, GA. Since the pilot was a 1-meter unit, the same size as a commercial installation, the trial was commercial scale. Up to a 23% increase in solids was realized, which is slightly *better* than the laboratory results. The results are presented in the attached manuscript entitled *Sludge Dewatering by Impulse Drying*, which was presented at the 1997 American Filtration Society meeting in Minneapolis.

Status

IPST has applied for a domestic patent on sludge impulse drying, and is contemplating filing in Germany and the UK. Ashbrook Corp., the largest belt press manufacturer in the world, has agreed to commercialize the invention, and an agreement is being prepared for signature. Our goal is to have a working model demonstrated in the field in this fiscal year.

Impulse Drying Sludge

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Keywords: Heat, Pulse, Dewatering, Primary, Secondary, Municipal

Abstract

In a new approach to energy-efficient sludge dewatering, sludge is contacted briefly under pressure by a hot surface. The steam generated at the interface between the sludge and the surface forces out some of the water in liquid form. Laboratory demonstrations with belt-pressed primary sludge from a paper mill removed more than 20 additional percentage points of water. Corresponding values from municipal sludge and from a mixed primary/secondary industrial sludge were 10 and 15 additional percentage points respectively.

Impulse drying was developed for drying paper (1,2). The wet paper sheet contacts a hot roll, and the steam pressure generated at the roll-sheet interface expels some of the water in liquid form, thereby conserving the energy that would otherwise be required for evaporation. A difficulty is that pressure differentials developed within the sheet may cause delamination (3-7), and special roll surfaces have been developed to control heat transfer to the sheet (8,9). Since delamination is not an issue with sludge, a laboratory simulation with an electrohydraulic press was conducted to determine whether the impulse drying concept could be applied to sludge. For paper the results of the laboratory press correspond to those achieved with a pilot impulse dryer.

The press used (illustrated in Figure 1) was designed to simulate the transient mechanical and thermal conditions, and the pressure profile that a sample would experience in a commercial impulse dryer. The thermal profile was simulated by using a platen of the same composition as the surface of the roll press maintained at the operating temperature of the process. As the dominant direction of flow is out-of-plane, the electrohydraulic press provides an excellent simulation of the impulse drying process (10).

A blotter is placed between the sample and the felt to impede solids movement to the felt. The sample, blotter, and felt are weighed before placement in the nip. The hydraulic system is activated to give a haversine pressure pulse of 140-1500 ms duration and a peak pressure between 400 and 1200 psi. The sample, blotter, and felt are reweighed after the impulse, and the water removal calculated. For paper, the water loss compares well with values obtained from the IPST's pilot impulse dryer.

Primary sludge from Riverwood International's Macon GA facility was belt pressed at the mill to 30% solids. The mill produces liner and coated board and uses 50% recycle. The sludge was sent to Ashbrook Corp., Houston TX, where it was further dewatered to 39% solids using their state-of-the-art high solids (14 roll) Winklepress. We were able to impulse dry the same sludge with a contact time of 0.7 sec. to more than 50% solids, as shown in Figure 2 (11). This figure is only one example of multiple measurements made at different temperatures and nip residence times. The lower line reflects a run at room temperature where the cold roll essentially acts as a press. Clearly, pressing alone leads to minimal additional dewatering. The upper line shows that impulse drying at 350°C takes the solids level to almost 60%. A small part of the water lost is released as steam. If the yardstick is weight gained by the blotter instead of weight lost by the sludge, then the solids level attained by liquid water loss is 52%, with the remainder evaporating as steam. However, the loss as steam is overstated because the blotter does not capture and hold all the water released from the sludge. Some of the water passes right through the blotter, and some visibly evaporates while the blotter is removed and weighed.

If the two lines in Figure 2 are extrapolated to zero pressure, they meet at the ingoing solids level. This suggests that that little evaporation occurs when the hot surface is lightly placed on the sludge. While increasing pressure will generate steam, the amount of steam developed must also be linear with pressure. The dwell time of 0.7 seconds is optimum for this sludge; shorter dwell times lead to reduced dewatering, whereas longer periods increase evaporative loss.

In order to determine the effect of initial water content, the Macon sludge pressed to 39% solids at Ashbrook as described above was impulse dried. A solids level of 50% was reached, a value lower than that obtained from the original 30% solids sludge. Furthermore, only 25% of the water released was lost as liquid, with the rest escaping as steam - a much poorer performance than the Figure 2 results. This probably occurs because a lower steam pressure is generated with the higher solids, which suggests that impulse drying is most efficient when there is sufficient water available to build up steam pressure at the interface. Our preliminary work suggests this optimum water to be at about 30% solids for the sludge used, which is typical of the performance of an inexpensive belt press. Hence, these experiments demonstrate the potential of retrofitting existing belt presses with add-on impulse dryers.

Impulse drying also applies to biological sludge, although dewatering occurs to a lower extent. Figure 3 illustrates our results with municipal waste activated sludge from the city of Houston, TX. This material was first belt-pressed to 16% solids at the facility and then impulse dried in the laboratory at 350°C with a contact time of 0.7 sec. The gain in solids is approximately 10 percentage points. Decreasing the contact time to 0.5 sec lowered the solids gain by about 2 percentage points across all pressures.

Results from impulse drying an approximately equal mixture of primary and secondary sludge from the Georgia-Pacific Big Island mill are illustrated in Figure 4. The contact time used was 0.5 sec., and a 15 percentage point improvement in solids was realized in the best case. Hence, the performance of impulse with this mixed sludge is intermediate between that of pure primary and pure secondary material. The effect of increasing temperature seems to be most pronounced up to about 200°C beyond which the gain is relatively small.

In summary, we have demonstrated the potential of impulse drying to sludge. The additional removal of water in liquid form has major cost reduction potential for drying, burning, or landfilling primary or secondary sludge. We envisage that a commercial impulse unit will follow a belt press as illustrated in Figure 5. Results from preliminary pilot runs with a 1-meter impulse dryer with sludge from Riverwood Macon correspond well to values obtained with the electrohydraulic press.

Acknowledgment

This study was funded by the Georgia Consortium for Pulp and Paper.

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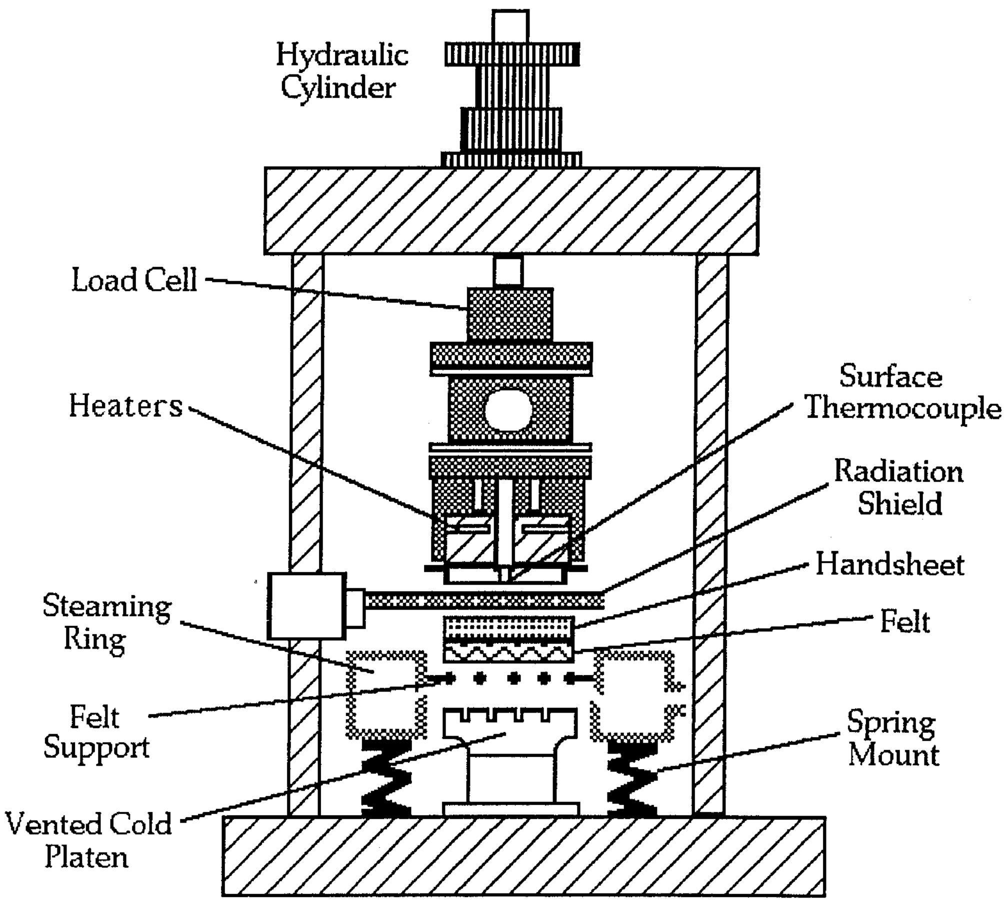

Figure 1. Schematic of the electrohydraulic press.

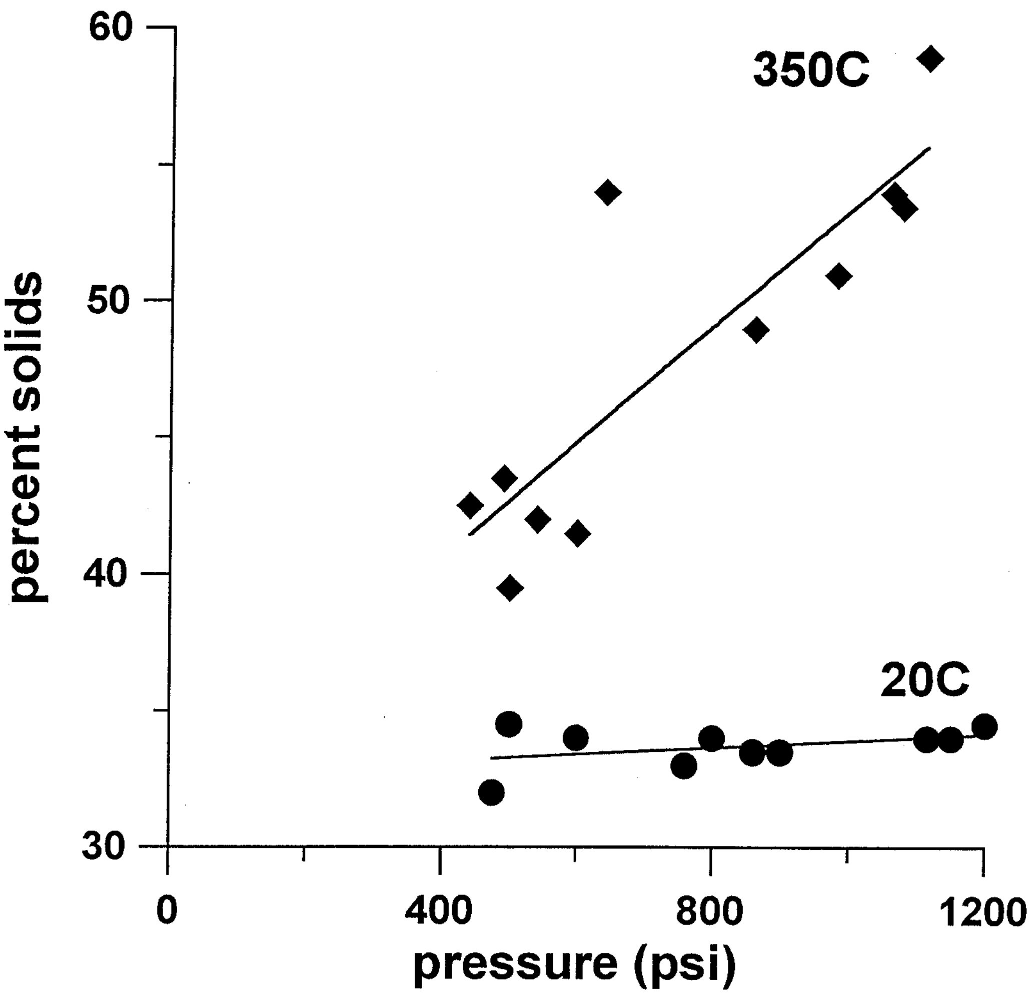

Figure 2. Impulse drying of primary sludge from Riverwood's Macon mill

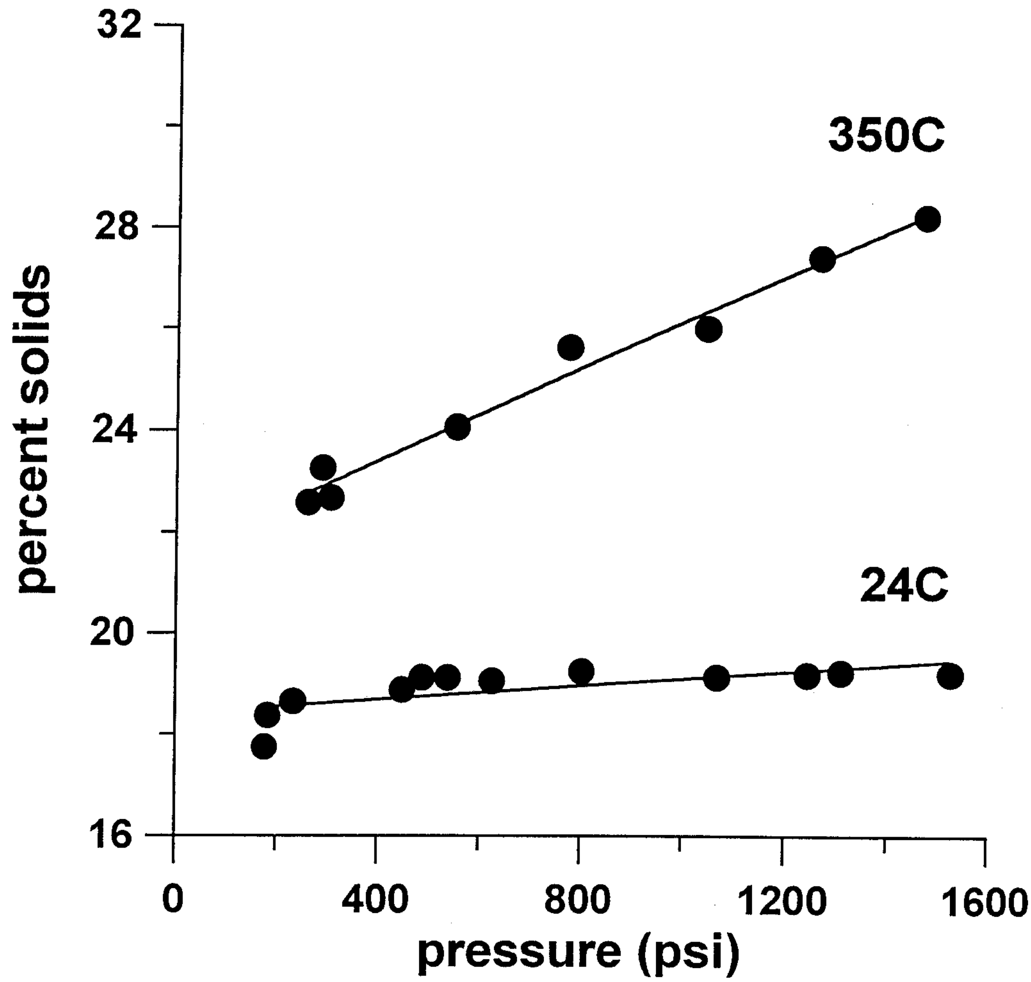

Figure 3. Impulse drying of waste activated sludge from the city of Houston

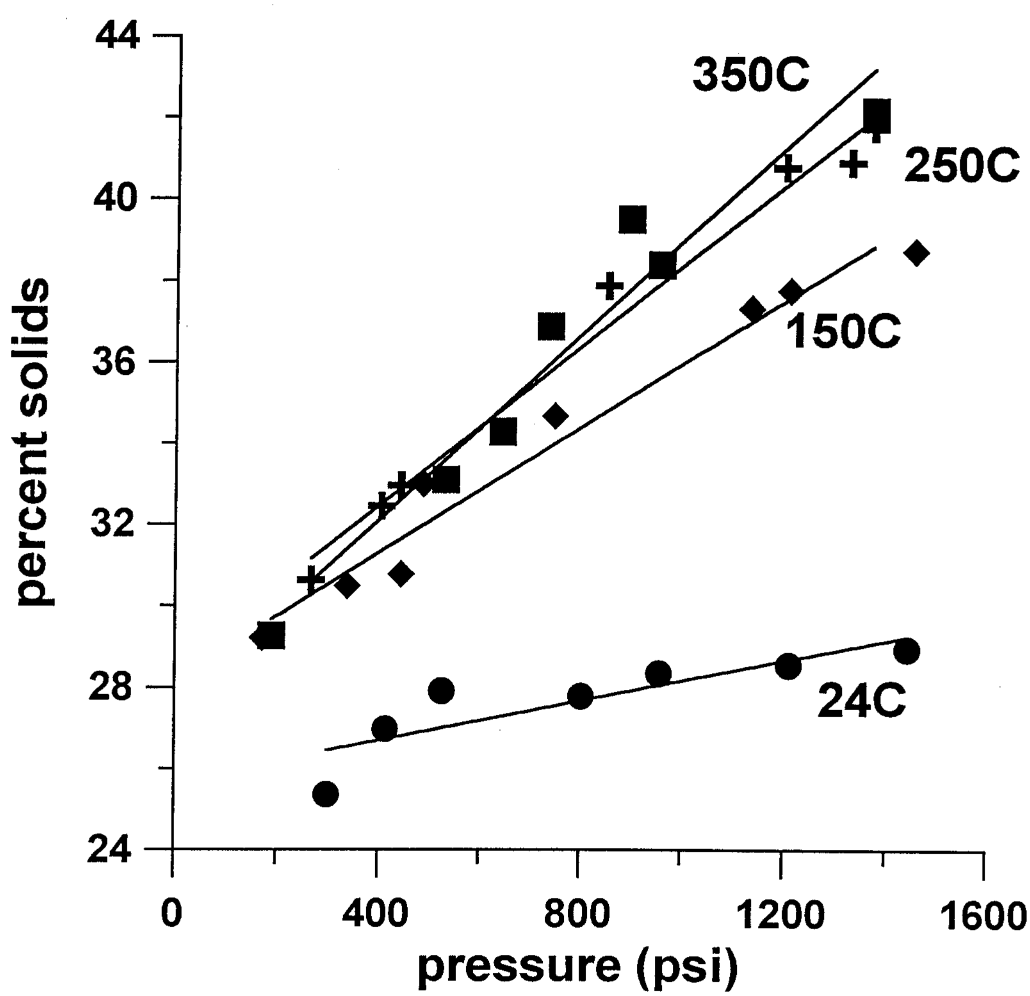

Figure 4. Impulse drying of mixed sludge from Big Island

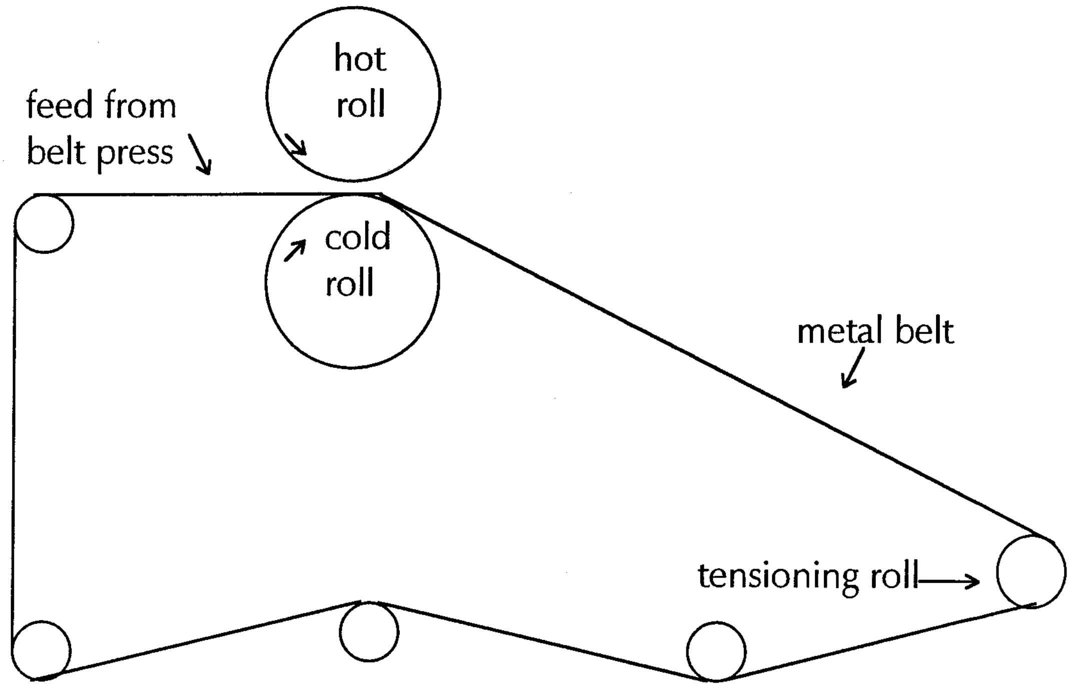

Figure 5: Schematic of a sludge impulse dryer