

**New Solids Flow Property Indices
for Predicting Roll Press or
Extrusion Press Performance**

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1.0 ABSTRACT

A new, easy-to-measure solids flow rate, index (FRI) has been developed by JR Johanson, Inc. This index, a combination of compressibility and air permeability of granular solids, seems to correlate well with press performance. This paper discusses this unique index, its measurement and its application for predicting roll press and extrusion press performance.

2.0 SOLIDS FLOW RATE TESTER

The Flow Rate Index, FRI [1], is measured by the unique tester shown in Figure 1*. The test cell (Figure 2) consists of a closed end cylinder with air and air pressure measurement connections below a screen bottom. The granular or powder test sample is placed in the cell, scraped level then weighed. The test cell is placed in position, the air connections made, the sample weight entered into the tester's computer memory by a key pad and the test begins. In about five minutes, the computer controlled tester has measured both the permeability and compressibility of the sample and displays the calculated FRI.

The ease of measuring FRI makes it ideal for correlating changes in press feed material with press performance. Necessary changes in press settings can be anticipated in advance and the appropriate changes made before a system upset occurs.

3.0 FLOW RATE INDEX AND QUALITY CONTROL

For those producing solids for others to press such as aspirin, chlorine, plastic for pressing parts or polymer extruder feed, the FRI is an excellent product quality control index. Instead of measuring the sieve size of your product, an indirect measurement of permeability and compressibility, the FRI directly measures the most important factors for press performance.

When a granular or powdered solid is pressed (in any kind of press), the solid's particles are squeezed together, compressing air within the voids. This air flows counter-current to the solids flow toward the lower pressure feed region. This flow causes an opposing air pressure gradient and retards solids flow into the press, causing a limiting solids feed rate. Figure 3 [2] illustrates this for a roll press. The same phenomenon occurs at an extrusion press feed throat or any process where solids are pressed.

4.0 FRI CORRELATION WITH ROLL PRESSES

Using our roll press computer simulation, we calculated the operation conditions for a 21-inch diameter roll press that

compacts solids to 20,000 psi solids contract pressure. We varied the solids throughput and the FRI of the feed material. All other variables including flake thickness, roll friction, internal friction and material specific gravity were held constant.

We calculated the feeder pressure required to operate the press. If the calculated feed pressure is below a two-foot head of solids, the press will operate using gravity feed. No force feeder is necessary. Above this pressure, a screw feeder is required. The results of this simulation are shown in Figure 4.

There is essentially a linear correlation between FRI and the roll speed for a given press feed correlation. The upper line shows the boundary between gravity feed and the need for a force feeder. For example, consider FRI = 2,000. The press can operate up to 140 pounds/minute per foot of roll space with gravity-feed. Above this rate, a screw feeder is required. As FRI decreases, the rate for gravity feed decreases proportionately.

At very small FRI's, the acceptable gravity feed rate is almost zero based on the top line: however, at high press throughputs, gravity feed becomes possible again as given by the lower line. This occurs with very fine powders when the press turns fast enough to trap all the air in the voids between the powder particles. None of the air escapes into the feed system to retard flow [2]. This same phenomenon may occur in extrusion or even punch type presses.

5.0 FRI CORRELATION WITH EXTRUSION PRESSES

Figure 5 shows experimental results of FRI correlation with the limiting rates of a plastic powder through an extrusion press. In this case, all the rate limits shown were caused by powder backup at the press feed throat and not by limits further into the press such as rate limits, steam release or air entrained in the extruded product. There is no evidence in this experimental data of the lower limiting line for gravity feed. However, we also do not have data for extremely low FRI materials.

6.0 FRI CORRELATION WITH TABLETING PRESS LIMITS

The correlation of FRI with tableting press limits or punch-pressed metal or plastic parts has to do with die fill rates and limiting rates from hopper outlets.

The FRI was initially developed to describe the limiting flow rate of finely divided solids from hopper outlets. In this case, the powder is compacted by its own weight. This compaction squeezes air from the voids. As the solids exit the hopper, they expand and enlarge the voids between particles. Air rushes in to fill the void and opposes solids flow. A limiting rate results. Consequently, the FRI correlates well with capsule fill limiting rates or die fill limiting rates where the feed to the die surface is the limiting factor.

The FRI will also correlate well with back flow or powder escaping around the ascending piston. The tablet capping phenomenon (breaking of the punch-formed product in striations parallel to the compression) will also correlate with FRI since capping results from entrained air.

7.0 CONCLUSION

We now have a valuable tool for quickly assessing a very important, finely divided solids flow property. The resulting FRI index can be correlated with various limiting rate phenomena plaguing solids pressing problems.

* Developed by JR Johanson, Inc. US and foreign patents pending.

- [1] Johanson, J.R. Bulk Solids Flow Indices: A simplified -evaluation system. 1991.
- [2] Johanson, J.R. Reducing Air Entrainment Problems in Your Roll Press. Powder and Bulk Engineering, February 1989. pp. 43-46.
- [3] Johanson, J.R. Predicting Limiting Roll Speeds for Briquetting Presses. "Proceedings 20th Biennial Conference of the Institute of Briquetting and Agglomeration," Vol. 20, September 1976, pp.251-263.

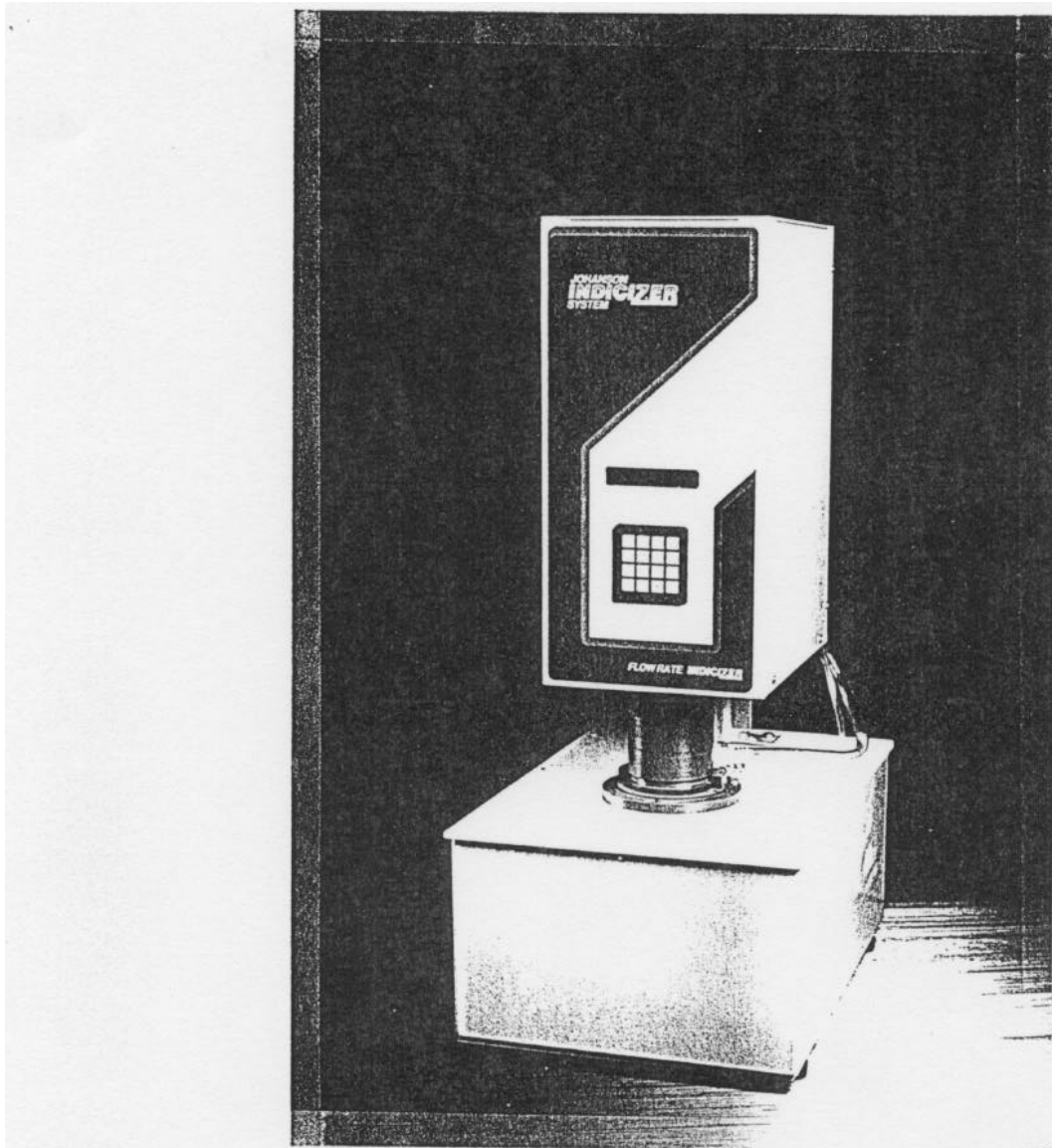


FIGURE 1: JR JOHANSON'S FLOW RATE INDICIZER

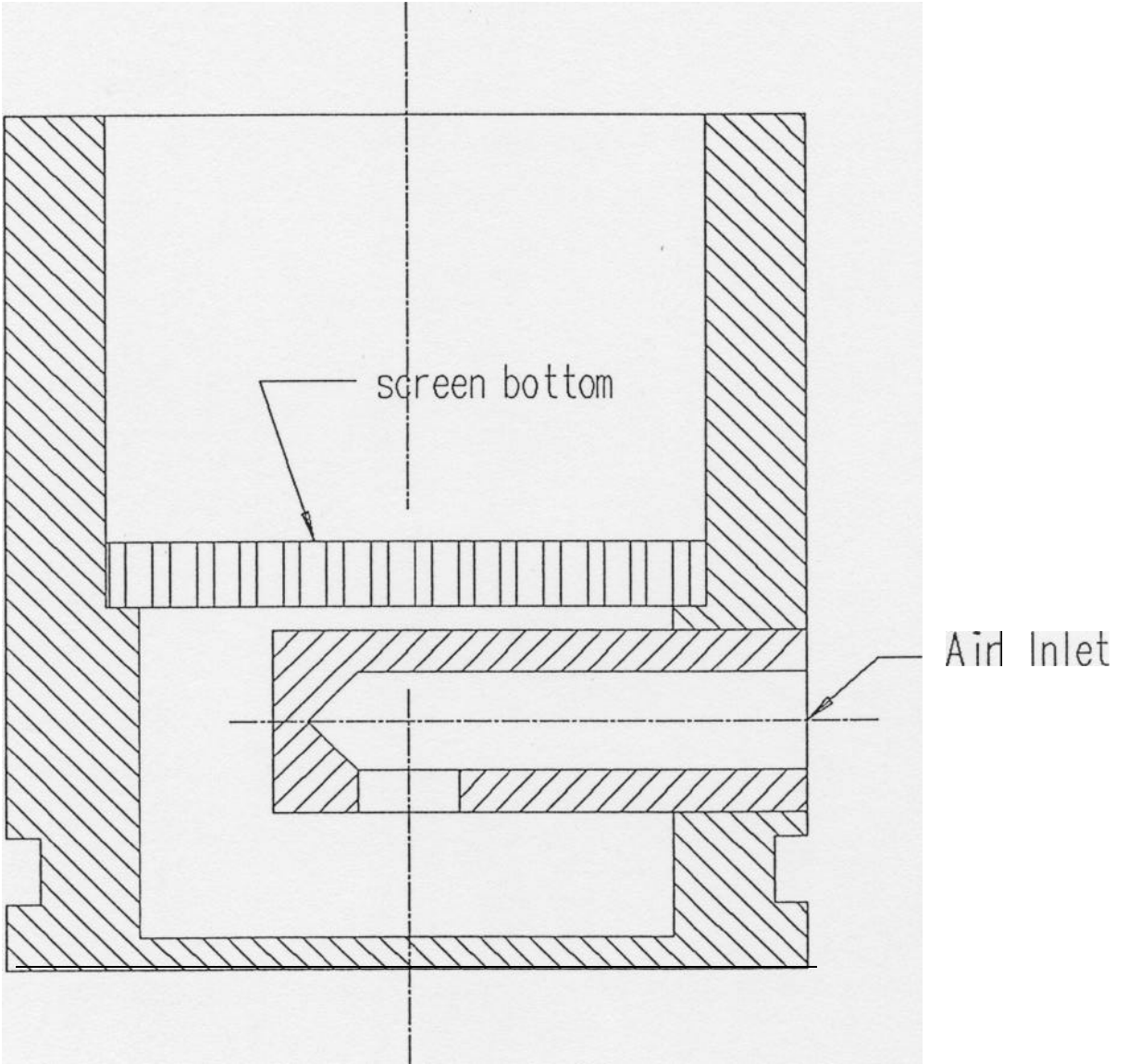
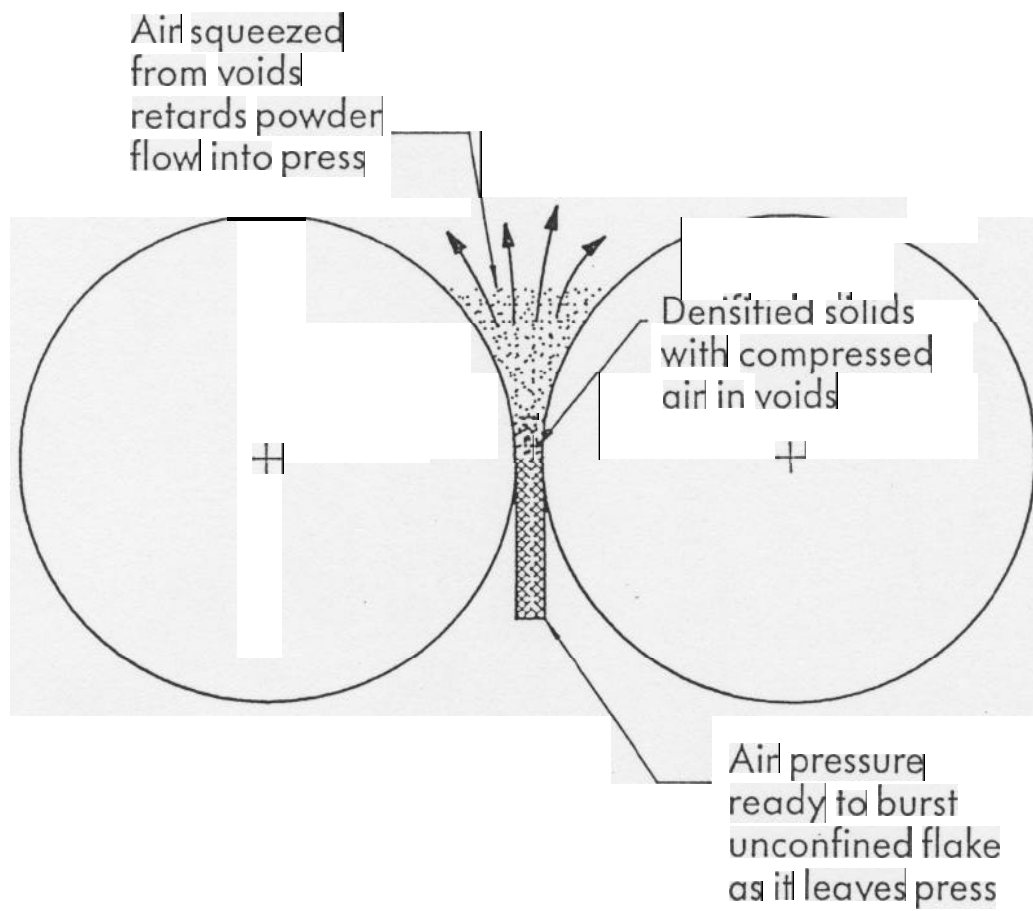


FIGURE 2: FLOW RATE INDEX TEST CELL

Fig. 3 Effects of entrained air on feeding and discharging



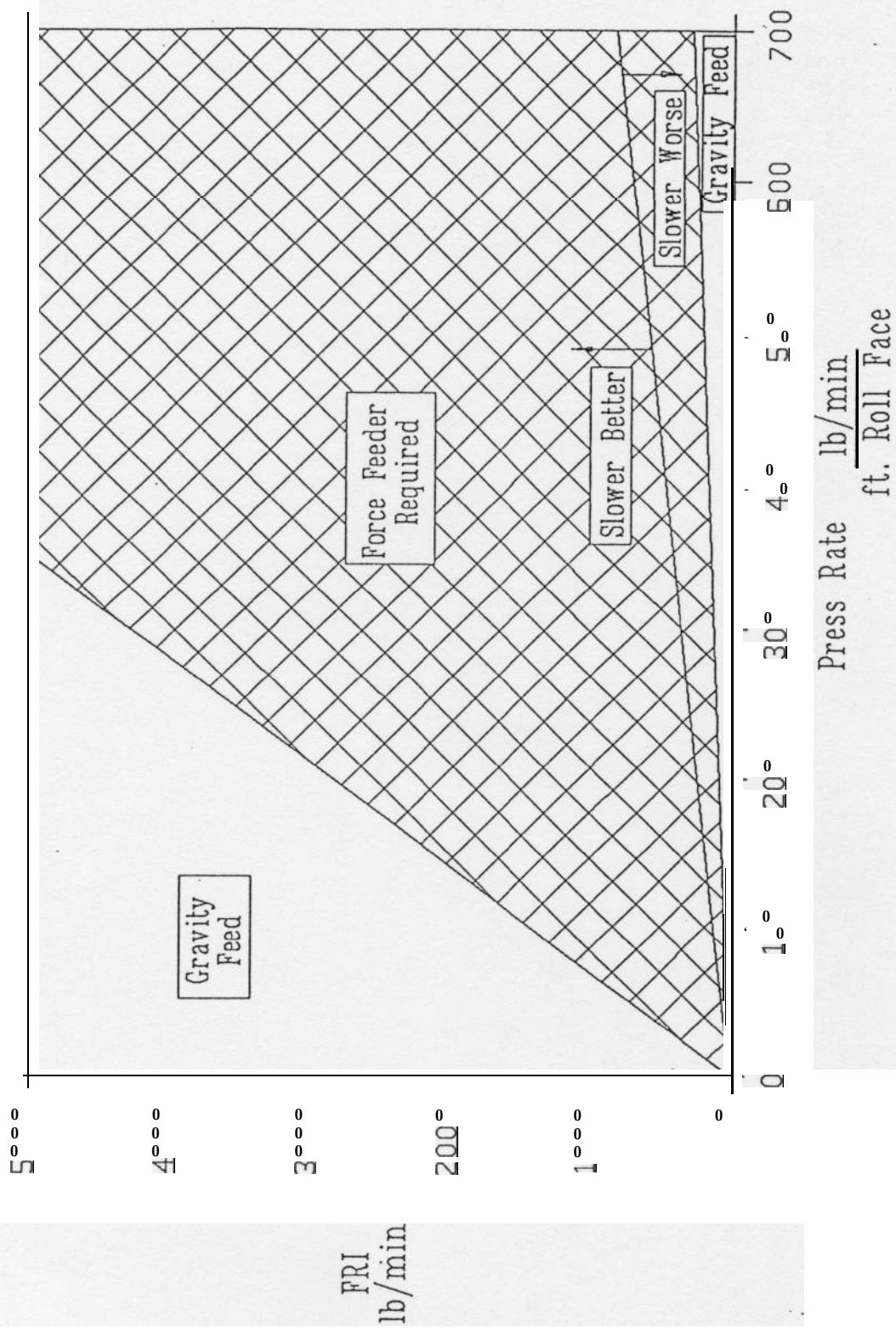


FIGURE 4: CORRELATION OF DATA FOR A 25-INCH DIAMETER ROLL

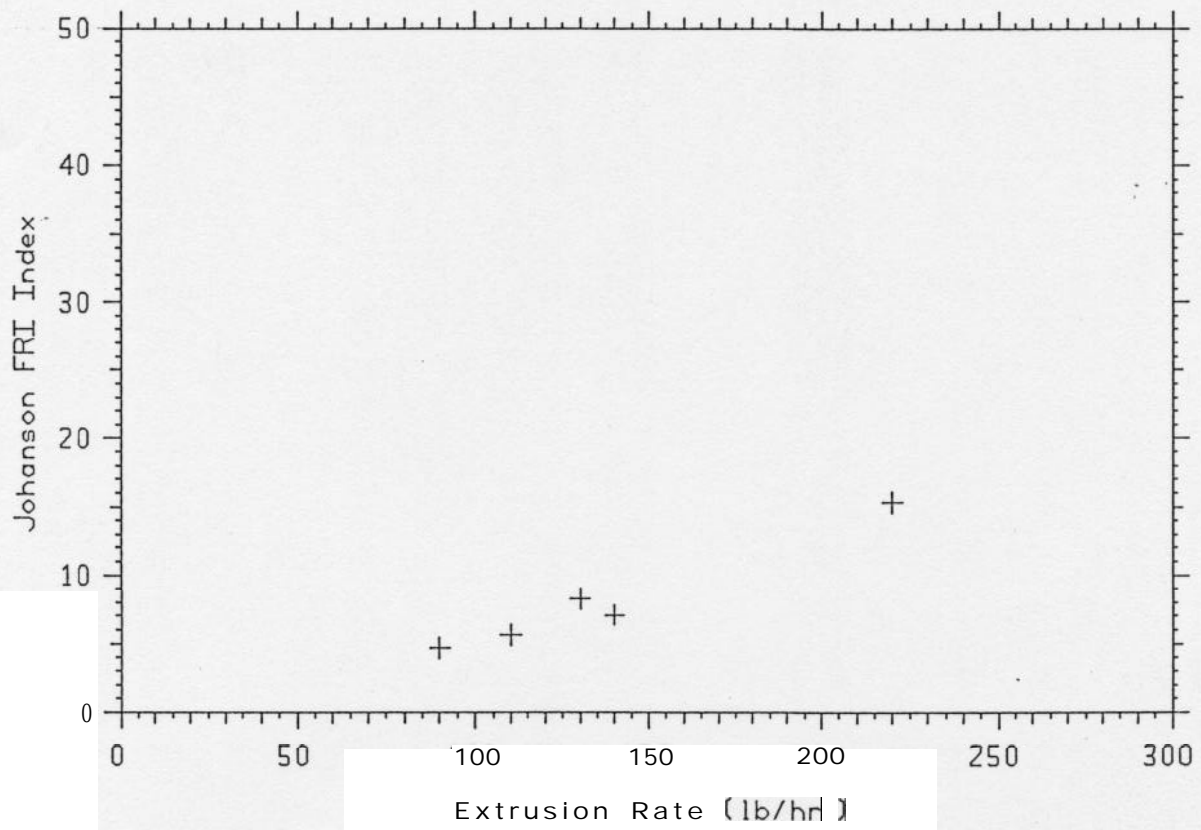


Figure 5 FRI Corelation with limiting extrusion press rates for plastic powder.