

INDICIZER

APPLICATION

GUIDE

VER 1.20

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PREFACE

Practically all of the information contained in this guide is drawn upon the vast knowledge of Dr. Jerry R. Johanson. He has been extensively researching and developing every aspect of the solids handling field for 40 years. We give full credit for this guide to information that he has developed.

We also would like to make the following disclaimer: Material sample and test conditions may not reflect actual plant operations. Material flow characteristics can vary as test conditions change. Temperature, particle size, moisture, freshness, and chemical changes may significantly affect Indices values. Care must be given to insure that the test sample and the test conditions are representative before the any tests are valid.

INDICES DEFINITIONS AND GENERAL FLOW INDICATIONS

ARCHING INDEX (AI)

AI is the recommended outlet diameter to ensure arch collapse in a conical bin or a measure of a powder's tendency to bridge over hopper outlets. **AI** predicts the recommended hopper outlets to eliminate arching, segregation potential, packaging fill weight variations, and the effect of vibrators and flow aids. In general, a higher **AI** indicates poor flow and a lower **AI** indicates better flow. For example, a powder with a higher **AI** tends to stop flow in hoppers, increase variations in tablet weight, increase difficulty in filling capsules, and decrease the ability to act as a dry carrier for aerosols. There is one positive to a higher **AI**, and that is a decreased tendency to segregate by particle size.

RATHOLING INDEX (RI)

RI is the recommended outlet diameter to ensure rathole failure and cleanout in a funnel-flow bin. **RI** Predicts ratholing potential, lump formation, tableting strength, agglomeration potential and flushing potential. In general a higher **RI** indicates poor flow and a lower **RI** indicates better flow. For example, a higher **RI** indicates a greater tendency for a powder to hang up at container walls, and to form agglomerates. The positive for a higher **RI** is an increase in tablet strength, or a decrease in pressure to achieve acceptable tablet strength.

FLOW RATE INDEX (FRI)

FRI is the maximum solids flow rate expected after deaeration of a powder in the bin. **FRI** predicts limiting feed rates from hopper outlets, fluidization and air current segregation potential, flushing potential, deaeration time in containers, roll press rate limits, capping tendencies and capsule fill rate limits. In general a higher **FRI** indicates better flowability. A smaller **FRI** indicates increased variability in tablet weight and an increased tendency for tablet capping. The **FRI** is also useful for correlating particle sizes, and size distribution if the mean particle size remains constant. A lower **FRI** indicates a smaller particle size or a wider size distribution if the mean size remains unchanged.

FEED DENSITY INDEX (FDI)

FDI is a measure of a powder's density at the outlet. **FDI** predicts feeder gravimetric rates and when compared with **BDI**, gives the range of densities possible within typical processes. There is no positive or negative direction for the **FDI**; however, it is useful to note that as the **FDI** decreases, feeder speeds need to increase to provide the same gravimetric rate. As the **FDI** increases, the particle-specific gravity is also likely increasing. If the particle-specific gravity is constant (e.g. the same chemical composition), then the increase is associated with a wider particle size distribution or a less cohesive powder.

BIN DENSITY INDEX (BDI)

BDI is a measure of a powder's density in a container. It is also useful in predicting bin gravimetric capacity and loads on bin walls. As with the **FDI**, there is no definite negative direction associated with the **BDI**. The trends predicted are similar to the **FDI**, except this index has little sensitivity to variations in powder cohesion, and a decrease in the **BDI** means the bin or hopper will hold less weight.

SPRINGBACK INDEX (SBI)

SBI is the percentage springback after consolidation. **SBI** predicts special hang-up problems related to elastic windup. Any value less than 3 is insignificant.

HOPPER INDEX (HI)

HI is the recommended conical hopper half-angle to ensure flow at the walls. **HI** predicts hopper slope angles required to cause flow at the walls, chute segregation potential and hopper wall angles for cleanout. The negative direction for the **HI** is a decrease. A lower **HI** indicates the need for steeper hopper angles to eliminate ratholing type hang-ups in containers, less uniform tablet compression from the top of the tablet to the bottom, and a greater force to remove the tablet from the die, which increases a tablet tendency to break when ejected from the die.

CHUTE INDEX (CI)

CI is the recommended chute slope angle at impact points. **CI** predicts buildup in chutes, feeders, conveyors and press feed shoes. An increase in **CI** is a negative, and indicates a greater tendency for a powder to stick to container walls, augers, belts, pneumatic conveying bins, mixing paddles, tablet press guides, tablet dies, and aerosol dispensing equipment. With increases in **CI** difficulties might exist in dry cleanout of equipment.

COMPRESSIBILITY INDEX (COM)

COM is a measure of a powder's compression tendency. The usual negative direction for **COM** is an increase, which indicates greater packaging fill weight variation, less uniform density in packages. COM is calculated as **(BDI/FDI-1)**.

INDICES APPLIED TO PROCESSES

TABLETING

Typical difficulties associated with tableting include hang-ups in feed hoppers, tablet capping, non-uniform tablet weights, dissolution rates and tablet strengths. This section discusses applying the Johanson Indices to determine the tableting potential of new formulations.

Hang-Ups in Feed Hoppers

There are three potential formulation hang-up problems in feed hoppers. First, the new formulation may arch over the hopper outlet. The **AI** identifies this quickly, which must be less than the hopper outlet if the hopper is conical. The higher the **AI** the more likely you are to have a poor flow condition. The basis for running this index is the diameter of the feed hopper. Second, the new formulation may have insufficient flow rates through the feed hopper. This is quickly identified by the **FRI**, which uses the hopper's top and bottom diameter as the indices test basis. Third, the hopper walls may not be steep enough to cause flow along the walls thereby causing a rathole. This requires both the **HI** and the **RI**, which uses the hopper diameter as the indices basis. Assuming the hopper is conical, the hopper angle measured from the vertical must be less than or equal to **HI** or the **RI** must be less than the outlet diameter. We see from this that the Johanson Indices can directly predict the behavior of the new formulation.

Tablet Capping

Tablet capping (separation of the top and bottom of the tablet) is caused by excess air entrainment in the powder and is accentuated when the formulation sticks to the piston. The new formulation can be evaluated by measuring the **FRI** and the **CI**. The smaller the **FRI** the greater the tendency to cap. Conversely, the larger the **CI**, the larger the tendency to cap.

Non-uniform Tablet Weights

Non-uniform tablet weights may be associated with hopper flow; however, they may occur even with good hopper flow. A good indicator of the potential for this problem is the compressibility of the material. This can be calculated as (**BDI/FDI-1**). The larger this number, the greater the chance for non-uniform

tablet weights. **CI** may also provide an insight into this problem, but more as an acceptable or nonacceptable cut-off, rather than a continuous variation. **CI** will indicate when buildup will occur on the feed shoe. If the **CI** is large, buildup and unpredictable sloughing off of agglomerated powder will occur. These precompacted chunks may dramatically and randomly affect the tablet weight.

Tablet Strength

A higher **RI** indicates an increase in potential tablet strength, or a decrease in pressure to achieve acceptable tablet strength. With less pressure required to make tablets, the tablet will have greater porosity, which will reduce the tendency for tablet capping, and cause faster tablet dissolution rates.

Dissolution Rates

The **COM** has shown direct correlation with tablet dissolution rates. This is because a greater porosity suggests a faster dissolution rate.

CAPSULE FILLING & PACKAGING

When filling capsules or other packages, problems arise from segregation and fill weight variations. The Indicators do well in predicting both of these as they relate to any type of filling.

Segregation

Segregation is covered in detail in a following section of this guide.

Fill weight variations

Fill weight variations are caused by at least three mechanisms: First, limiting flow rates due to poor permeability of the material. Second, arching hang-ups due to the cohesiveness of the material. And third the compressibility of the material.

The limiting flow rate can be directly measured using **FRI**. A material with a higher **FRI** will flow without limits. One with a low **FRI** will flow in a start and stop manner. This erratic flow in conjunction with a timed filling process causes variations in package fill weights. Generally a material with a **FRI**>200 is free flowing.

Remember that arching hang-ups are caused when a material will not flow because it builds strength under compaction and arches at the outlet. **AI** and **RI** are direct measurements of a materials cohesive strength. The lower each of these indices is the less chance there is of fill weight variation due to arching at the outlet. A large **RI** indicated the likelihood of soft lumps reaching the outlet and interfering with out flow.

You can also predict the potential of weight variations by examining the **COM (BDI/FDI-1)**. A large **COM** predicts a greater probability for fill weight variation due to differences in the materials densities.

BLENDING

To understand how to effectively blend a material and keep it blended you must understand how to avoid segregation. As discussed later, the Indicizers® are very effective at predicting segregation.

The Indicizers® can also be used to evaluate blenders and their effectiveness. Lets look at how the indices relate to blender evaluation.

Arching Index - In blenders it predicts arching during blender gravity discharge of blenders and the tendency of solids to demix.

Ratholing Index - In large, rotating shell blenders, the index predicts the cohesion of solids at the bottom of the mixer and the tendency to form cohesive chunks and the need intensifies in mixers.

Flow Rate Index - This index indicates the fluidization problem potential of a material in a blender.

Feed Density Index and Bin Density Index - They are useful in calculating blender, feeder and bin capacities.

Hopper Index - This index is especially important if the blender must discharge in mass-flow (flow at the walls). Mass-flow can be critical for any blender that does not have active internal agitation during discharge.

Chute Index - This index is the recommended chute angle to prevent material buildup at solids impact areas. This has application to blender discharge chutes and smearing of the solids by mechanical agitators.

For information on specific blenders please refer to the paper *Blender Selection Based on Material Properties* by Dr. Jerry R. Johanson at <http://www.indicizer.com/>

ROLL PRESSING

The **FRI** index provides an excellent correlation for maximum extruder and roll press feed rates for fine powders. This is expected because the extruder feed throat and the feed box of a roll press are subject to the air squeezed from the powder in the press or extruder. This air counterflow holds up the powder and causes flow rate limits. At high press speeds, the air does not have a chance to

escape. This trapped air can cause the compacted solids leaving the press to explode and return to powder again. This sometimes causes a press to chatter. A larger **FRI** allows for higher feed rates and larger compaction densities.

PNEUMATIC CONVEYING

The **CI** index predicts build up on pneumatic conveying lines. Some materials (usually polymers) form thin (snake) skins inside of lines. When these skins loosen, they clog lines and other handling equipment. This phenomenon is a function of line velocity, impact pressure and temperature. **CI** measurements at various temperatures and impact pressures have been able to identify those materials that stick and don't stick on pipe walls. The higher **CI** is the more likely buildup will occur on pneumatic conveying lines

INDICES APPLIED TO PROBLEMS

SEGREGATION

There are more than a dozen types of segregation and we will examine how the Indices can predict the five most common types: sifting, angle of repose, fluidization, air current and chute.

Here is how the Johanson Indices are defined as they relate to segregation.

The Arching Index (AI) determines the recommended conical hopper outlet diameter required to prevent arching. It indicates the ability of small particles to sift between large particles, remain on large particle surfaces, or form agglomerates too great to fit between large particles. A slight increase in **AI** often prevents segregation.

The Ratholing Index (RI) determines the recommended minimum rathole diameter necessary to create rathole instability in funnel-flow bins. The **RI** is the potential of a component of fine particles to agglomerate during storage, before it is required for addition to a mixture. Agglomeration therefore changes the component's effective particle size. High **RI** may require increased power for proper mixing.

The Hopper Index (HI) is the recommended mass-flow conical hopper angle measured from the vertical. Differences between **HI** for various components can predict chute segregation.

The Chute Index (CI) is the recommended chute angle at impact points. The **CI** indicates if a mixture's components will segregate due to adhesion to chutes, at places where the particles strike the chute. A component with a large **CI** may remain adhered to the impact point, whereas a component with a low **CI** slides easily away from the impact point and may segregate. This same affect can also occur in blenders with paddle like bars or internal moving parts with close tolerances with stationary members.

The Flow Rate Index (FRI) indicates the limiting flow rate from a hopper outlet and is an indirect measure of particle size. When combined with the **AI** and **RI**, the **FRI** becomes a predictor of the effects that fluidization and air current have on segregation.

The Feeder Density Index (FDI) and Bin Density Index (BDI) are the minimum and maximum bin densities, respectively. These two indices provide a method of judging the segregation tendencies of the two components, due to fluidization. A large ratio of **BDI/FDI** combined with a low **AI** and **RI** will indicate a fluidizable material. This fine, fluidizable material will allow a larger particle size or heavier material (with a larger **BDI**) to penetrate the fluidized component.

These indices, as measured by the Indicizer, provide a complete quantitative description of the flow properties of a solid: consequently, they provide the means for incorporating flow properties into a prediction of segregation.

Here are the five most frequently occurring mechanisms of segregation.

Sifting Segregation

This type occurs whenever the major component consists of free-flowing particles, while the minor component also consists of free-flowing particles, but which have a mean particle size that is less than one-third of the size of the mean size of particles in the major component. Remember that **FRI** is an indirect measurement of mean particle size. A higher **FRI** correlates to a larger particle size. Process equipment imposes particle motion, causing fines to sift through the coarser solids. All chutes, hoppers, and batch blenders have this segregation potential.

Manufacturing the major and minor components the same particle size eliminates this type of segregation, as does the production of a major component with a smaller mean particle size than that of the minor component. Use the **FRI** to fine tune production and evaluate each batch before mixing components.

For sifting to occur, both the major and minor components will have an **AI** less than 0.2 ft and an **RI** less than 1.0 ft. (*Indices referenced in this section are all measured for a standard basis of D=10 feet and d=1 foot*) The **FRI** of the minor component will be smaller than that of the major component, but will be generally greater than 440 lb/min.

Angle of Repose Segregation

This segregation occurs whenever solids slide across each other as they are introduced into a container. Material producing a steeper angle of repose holds back and allows a material (with a less steep angle of repose) to slide freely to the bottom of the slope or pile.

Rotating shell-type blenders, stockpiles and bins are especially susceptible to this mechanism. Adding liquids or cohesive material to the fines may make the problem worse. However, premixing liquid with coarse material (before adding fines) causes fines to stick to the coarse particles and may reduce segregation.

A component's cohesiveness can influence the repose angle. For example, if one component's **AI** or **RI** is larger than the other component, the former will probably form a steeper repose angle than the latter component because **AI** and **RI** are direct measures of cohesion. However, particle shape and surface roughness can also significantly affect the angle repose for free-flowing solids. Rounded or smooth-surfaced particles form lower repose angles than flat, rough-surfaced or angular particles. A larger **FRI** may also indicate materials of lower repose angle. This mechanism is worse when the major component has the lower angle of repose; however, segregation can still occur if the major component has the steeper angle of repose.

Fluidization Segregation

Fluidization occurs when a mixture contains both: a free-flowing, fine major component that fluidizes easily (low **AI**, low **FRI**, high **BDI/FDI**); and also a relatively coarse, heavy minor component that easily penetrates the fluidized fines (low **AI**, high **FRI**, high **FDI**). Fluidization is especially active in air blenders, high-speed ribbon blenders, bins and piles. Factors that reduce the fluidization of fines therefore reduce the tendency to segregate. These conditions include: a lower blender speed: a reduction in air entrained as solids enter the container: the addition of liquid (even in small amounts): and the pre-agglomeration of the fines.

The presence of a fluidizable component of fines can be defined by an **AI**<0.3 ft, an **RI**<3.3 ft and an **FRI**<110 lb/min. In addition, this component will compress with **BDI/FDI**>1.20. Generally, the greater the deviation from the given maximums or minimums, the more fluidizable the component will be. This mechanism is less effective when segregating a material with a minor component of fines; although some fluidization segregation may occur between a fine minor component and a large, heavier major component.

Air Current Segregation

Air current segregation occurs as solids enter the processing equipment and superfines become airborne. These superfines migrate to the vessel walls or toward the dust collection system. This can occur if superfines are present, even if the quantity of superfine solids is a small percentage of the total. Addition of moisture will greatly reduce this type of segregation. If deposited in a fine spray during mixing, air-borne fines will agglomerate and fall with the coarse component. Adding liquid to the coarse, major component before introducing the fines to the mixer will cause fines to stick to the coarse solids and not become airborne.

The coarse major component will be characterized by an **AI**<0.2 ft, an **RI**<3.3 ft, and an **FRI**>440 lb/min. The fine minor component will have an **AI**<1 ft, an **FRI**>10 lb/min and a density ratio of **BDI/FDI**>1.50.

Chute Segregation

When a binary mixture slides down a chute, the particles accelerate and the thickness of the flowing stream thins. If the mixture becomes sufficiently thin, individual particles come into contact with the chute surface and hence their speed is influenced by their individual angle of surface friction to the chute. Particles with high angles of friction tend to dribble off the end in a trajectory close to the chute. Particles with low friction angles accelerate and are thrown further away from the chute end. Both the components must be free-flowing, with an **AI**<0.1 ft and **RI**<3.2 ft. In general, the major component will be coarser with **FRI**>100 lb/min, while the minor component will be slower moving and finer, with **FRI**<100 lb/min. The most important difference between the two components is that the slow moving component will have a smaller **HI** than the fast moving component. Generally, a larger **HI** (low friction coefficient) is associated with larger particle sizes. Segregation is negated to some extent, when the major component is slow moving this impedes the movement of the minor component, which is then carried with the major component. Consequently, when the minor component has a larger **HI** than the major component, chute segregation is slight.

For more detailed information read the article written by Dr. Jerry R. Johanson, *Predicting Segregation of Bimodal Particle Mixtures Using the Flow Properties of Bulk Solids*, at www.indicizer.com.

FLOODING AND FLUSHING

Flooding/Flushing (FF) is defined in powder handling as an uncontrolled or widely fluctuating material flow similar to water. Fine powders can even flow through small cracks and crevices including clearances in rotary air locks. This action is caused by excess air entrainment and often produces process instabilities.

The most frequent cause of FF is evident in a rathole –type flow condition. This flow pattern occurs whenever a hopper's walls are not smooth or steep enough to allow flow at the walls (funnel flow). If the rathole collapses when the bin is partially or completely emptied or if additional material is introduced into a bin with a rathole, the falling material can become entrained with air. To prevent FF in funnel flow bins, use **RI** and **HI** to evaluate the materials rathole potential and **FRI** to evaluate the materials FF potential. The lower the **FRI** the higher the potential for FF.

ARCHING & RATHOLING HANG-UPS

Archiving occurs in mass flow bins (flow along the walls) and literally means that the material is hung up inside the bin. To avoid arching, simply allow the outlet of the bin to be larger than **AI**.

If you have a funnel flow bin where the hopper angles too very flat to cause flow at the walls, you will notice inside the bin a large funnel from the top of the material down to the bin outlet, indicating a rathole. To eliminate ratholing, allow the outlet to be larger than **RI**.

Measuring **AI** and **RI** for a material with varying amounts of flow aid additive, such as fumed silica, allows the formulator to identify acceptable flow aid quantity and therefore minimize the cost. The **FRI** should also be measured because too much flow aid may cause a rate flow limitation.

CAKING

Caking, for the most part, is associated with crystal growth in solids with water-soluble components. Crystal growth requires conditions that leave super saturated solutions on the particle surfaces. Changes in temperatures and the associated moisture migration produce conditions for crystal growth. The Temperature Cycle Hang-up Indicizer allows the user to imposes controlled temperature variations. In this way, it is possible to simulate typical day/night temperature conditions in the test cell and to measure the **RI** for these conditions. The number of temperature cycles is the most important variable in building crystal growth strength in bulk solids. The Temp Cycle feature allows for a one-week time test to be completed in one day to get answers quickly

The **RI** index simulates conditions in railcars, trucks and supersacks. **RI** values, measured under controlled temperature conditions will predict caking of material received at the customer's plant. Caking can be expected as **RI** increases.

BUILD UP ON CHUTES

To eliminate material from building up on chutes at the impact points, measure the **CI** and adjust chutes to that angle at all the impact points.

LIMITING FLOW RATES

The **FRI** is a direct measurement of a materials limiting flow rate. Remember that **FRI** is defined as the maximum solids flow rate expected after deaeration of a powder in the bin.

When powders flow in converging hoppers, the powder compacts as the solids contact pressure changes. This increases the bulk-specific weight. If the hopper

has a vertical bin section above it and the bin is full, the highest level of compaction compresses and pressurizes the air in the voids between the powder particles. The pressure gradient from the pressurization expels some of the air from the top of the bin. As the solids flow in the converging hopper, powder expansion occurs, thus expanding the voids and reducing the air pressure even to a value less than atmospheric.

At the outlet of the hopper, atmospheric air rushes in to negate the low pressure in the voids. This on-rush of air creates an upward force that retards solids flow. A solid moving surface forms at the hopper outlet from which the powder slowly rains in small clumps. This is called a limiting rate condition. The worst case limiting rate occurs when solids sit in the bin and air pressure at the maximum solids contact pressure (at the top of the hopper) reduces to atmospheric. The actual limiting rate will vary from the expected solids flow rate, after a powder deaerates in the bin, to a total flushing condition depending on how fast the bin is filled, and how long it stands after filling before initiating flow.

MOISTURE CONTENT

With the **AI** and **RI** indices for a material at a range of moisture contents, you can decide what moisture will work in an existing system. Typically, the **AI** and **RI** decrease as moisture decreases.

The **AI** and **RI** can be used to quickly evaluate critical minimum batch drying times for materials. Moisture content correlates to a material's cohesive strength and both indices directly measure the strength of a material.

The **CI** is also moisture-sensitive. Sometimes the **CI** is greater than 90 degrees for a fine, wet material. This means special chute designs are required to prevent buildup at impact points. This buildup will eventually plug the chute if not attended to. Reducing the moisture will almost always reduce the **CI** and eventually reach an acceptable level for standard chute designs.

The **FRI** is another moisture sensitive index. Usually, with a fine powder, the **FRI** increases with a slight increase in moisture. This suggests that higher flow rates can be obtained with increased moisture content and that there may be a minimum moisture content for fine, dry powders. Too dry can be bad for flow rates as **FRI** might become too low. The indices can define the acceptable moisture range.

INDICES APPLIED TO QUALITY CONTROL APPLICATIONS

RAIL CAR'S AND CAKING

One of the many successes that Indicizer users have had is in the area of predicting and eliminating caking problems. A well-known chemical company that mines and processes one of their products in the California desert had struggled for years with rail car unloading due to extreme caking.

They were confident that their product was flowing well when it was initially loaded onto the rail cars, but was often difficult or even impossible to unload at their customers' plants. Sometimes even rejected completely upon arrival by the buyer.

What was happening in the weeks and sometimes only days as the product sat in the Hopper bottomed containers was moisture migration. When a material contains moisture and is subjected to changes in temperature, the water molecules tend to move and form new bonds within the material. In this case, the product was loaded into a rail car immediately after production, often to sit in the rail container for weeks waiting for the final approval for delivery to their customer. During the day, the temperature in the rail car sometimes reached 130°F. Then, at night, the cool desert temperatures would often drop to near 50°F. This dramatic swing in temperature, day in and day out, can cause even small amounts of moisture within a material to migrate out toward the walls, continually reforming bonds until a material is left almost as one large hard mass. It had been found that after even just days of storage and a mere 100 miles of transport the product would arrive so hard that not only would it not flow out of the opened hopper bottomed cars, but had to sometimes be jack hammered or hydraulically blasted out.

The chemical company suspected that storage time and temperature were involved but had no way of knowing how much or how to measure it.

After some preliminary testing with the Johanson Temp Cycle Hang Up Indicizer, a customized user-defined test was set up on which the Indicizer would replicate the temperature and day/night cycling at an accelerated rate to measure how fast the product gained strength.

It was soon determined that the average production run could sit no longer than 3 days before delivery and unloading.

Because flow characteristics varied from batch to batch, continuous post production batch testing was implemented to confirm storage limitations of each run.

QUANTIFY PRODUCT BATCH CHARACTERISTICS FOR FURTHER PROCESSING

A large U.S. chemical company that specializes in flooring products recently found success with the Johanson Hang-Up Indicizer. The company, which was concentrating on improving its vinyl flooring product line, found that they had to continually use flow aids in assisting their product through its roll production. These additives proved to be not only costly but often affected color and other characteristics of the final product.

They were searching for a way to measure small pre-production samples of their material and obtain data that could then be correlated to success or failure before full-scale production went underway. Finding the right balance between too much and too little of the flow aid was achieved when new material was tested against successful batch of data or indices, (in this case AI or Arching Index, and RI or Rathole Index). For instance, they found that a successful batch had an AI of between 2.0 and 5.5. When a new formulation was developed, it was tested using the Hang-Up Indicizer and an AI was obtained and compared to this "window" of acceptability. In the case of the new sample, an AI of 4.3 was measured after the flow additive was introduced assuring them success throughout the full production batch.

Because of constant production and continuing new product formulations the company found that regular pre-line Indicizer testing would prove essential in assuring process success before each run got underway. This pre-testing helped them fine tune the percent of additive needed for each product or batch and helped avoid any full production shut down before they occurred.

PREDICT THE SUCCESS OF NEW FORMULATIONS IN EXISTING EQUIPMENT

A successful pharmaceutical company with production and research facilities throughout the East was expanding their manufacturing by subcontracting the actual powder-drug production to a joint venture company in the West. The mother company would then take the drug in bulk powder form and complete the production by tableting and otherwise packaging the final product.

Having already used the Johanson Indicizer System, the parent company had built up a database of material properties based on the Johanson Indices. Focusing on indices they found most useful, they had established requirements for physical functionality success as demanded by their equipment, especially feed hoppers, tableting presses, and capsule filling units.

Understanding the handling characteristic criteria that had to be met by the subcontractor before the parent company could receive the chemically completed powder drug encouraged them to obtain their own Indicizer System. Utilizing the FDI (Feed Density Index) from the Flowrate Indicizer, which defines the rate by weight that a material is expected to flow from a given hopper, and the AI (Arching Index) and RI (Rat-holing Index) from the Hang Up Indicizer, they could assure their material would process well in equipment three thousand miles away.

Being able to successfully meet flow and handling criteria of the parent company also assured them that future production contracts would continue to be offered.

IDENTIFY TROUBLESOME MATERIALS BEFORE YOU SHIP TO CUSTOMERS

A foreign chemical company uses the Johanson Indicizers to identify troublesome solids before they ship them to customers. After unsuccessful attempts to characterize bulk solids by other standards, they purchased a complete set of Indicizers – A Hang-up, Flow Rate and Hopper model.

Because the testers are easy to use and the data (indices) easy to interpret without extensive training, this company began immediately to evaluate material their customers described as difficult to handle, particularly during container unloading after transport. The company used indices data to monitor their product and to make necessary process and formulation changes that would enhance their products' competitiveness. They installed a dense phase pneumatic conveying system to replace their dilute phase and reduce particle degradation. They also changed their process to produce larger particles and obtain as narrow a size distribution as possible. Finally, they stabilized their dryer's feed pulses to reduce caking. Using the Indicizers at each step to monitor product quality, the company eventually produced a lump-free powder that unloaded quickly and without hang-ups at their customer's plants.