Adaptive Speed Control in Conveyor System Design

Reducing operating costs and system maintenance while improving the operations environment

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Introduction & Overview

Conveyor systems have long been the heart of the modern material handling industry. Their implementation has been through various vendors and integration teams throughout the industry. The advancements in technology has allowed them to continually improve the accuracy and speed at which product can be moved. Rudimentary design philosophy for new a new system requires that system to be designed to handle a customer's current production capacity plus any near term future increase in production capacity that the customer plans to see through growth.

Many times systems are designed to run at a customers designed rate continuously once the systems start button is pushed. This works well for systems that run consistently at or near their design capacity without a lot of throughput fluctuation. More often than not though, most companies find they have more fluctuation in their production. They then find themselves with a system that is able to handle their peak volume, but at many times a system that is completely underutilized.

In recent years material handling customers have also found themselves under pressure to conserve resources and reduce their carbon footprint on society. There is a large push to implement practices that are more in line with the "Go Green" movement that is happening across industry sectors. The cost of basic resources has also put more emphasis on doing more with less. A conveyor system that runs at full speed all the time even when production capacity is at 50% is generally not a ringing endorsement for energy or resource conservation. It is also more costly to run and maintain than it needs to be. This would be similar to having light switches in your house turn on every light in the house instead of each switch only controlling the room that it is a part of. Separating the switches allows you to put the light where you need it when you need it.

With the associated cost increasing to operate systems continually growing, customers found themselves looking to spend more on projects up front to reduce their cost of ownership over the lifespan of a system.   To help material handling customers solve these two main problems and reduce their cost of ownership overtime, integrators began to use a combination of advancements in technology and flow control philosophy. They began to design in and retrofit systems with what was known as "Energy Conservation Logic". This basically added product detection sensor to various points in a system, typically one on every section of transportation. This allowed the movement of product to be monitored and if no product is seen in a configured time period the transportation section would shut down. It would similarly start up if product was detected in route to a section that was shut down.

The increase of product detection sensors allows the integrators the ability to improve system diagnostic and understand the movement of product with in the system to much higher levels. The philosophy of "System Flow Management" was developed. The increase amount of data allows the integrators to start and stop different area based on the perceived volume in a given section of the system. These techniques allowed the customers to start realizing some cost savings on their ownership of a system.

To take this to the next level and offer customer even more value in there system integrators started to offer more flexible systems utilizing variable frequency drives, VFDs. Coupling the VFD's with System Flow Management integrators are now able to offer customers the option of adding "Adaptive Speed Control".

What is Adaptive Speed Control?

Adaptive Speed Control is additional programing algorithms and hardware put into the design of a material handling system that allow the material handling system to synchronize with the demands of the customer's production systems. It utilizes the information gathered from a systems flow management programming in conjunction with the additional VFD hardware to modulate the systems throughput and speed to match production capacity up to the systems designed maximum rates. This allows a more dynamic system and ultimately puts more flexibility into the customer's hands.

What does it take to implement?

In general an integrator needs to understand the level of Adaptive Speed Control a customer wants to implement. Basically the more systems or components that need to fluctuate in speed the more upfront cost the customer will need to bear. For adaptive speed to be implemented a customer will need to have two things.

The first thing needed is a way to get the data required from a flow management algorithm that can be used to determine what speed the system should run at and when to initiate a change. This will typically involve the addition of package detection sensors to the material handling system. Algorithms are then written to constantly monitor these sensors. Although theoretically a system could be setup to constantly react to the algorithms, it is more practical to define different system levels to run at. Once these levels are set, thresholds can be setup to allow the system to move from one level to another. This methodology has produce very solid and stable operating systems. It also improves the tracking reliability of systems that need to track product and product data within the system.

The second thing needs to be able to allow the system to react to decisions made by the flow management algorithms. This typically has required an integrator to design in VFD's on the system if they were not already required. This is the part of implementing adaptive speed that adds the most upfront cost, but is what also allows the customer to realize the multiple benefits that being able to reduce the speed will bring over time.

In general integrators will give the customer the capability to enable and disable the adaptive speed control in case an override is needed. When disabled the customer can select what level they want the system to run at.

Both of these items require additional design and engineering time to accomplish during the implementation lifespan of a project. As with most things, planning for adaptive speed control in the beginning of a project will reduce the amount of time it takes to implement and test. Leaving this for the end of a project or trying to add it in after the fact requires roughly twice the effort.

What benefits does adaptive speed add to the system?

There are three main benefits that a customer can realize from an adaptive speed controlled system.

The first benefit and probably the most significant is power consumption. The addition of VFD's to a system allows a more even demand of power from a customer's power company. Standard motor starters produce high inrush spikes of current and tie the motors highly inductive load directly to the company's power grid. This is in turn reflected to the power company if there are no isolation transformers in place. These high spikes and full loads have a negative effect on the bill a company sees from the power company. VFD's take the inductive load and turn it into a capacitive load that is able to even out the required current by a motor. It also allows acceleration and deceleration curves to be put in place that helps mitigate the instantaneous spike that is generated from the starting of a motor. The VFD also allows for a motor to be run at slower speeds which also lowers the overall current required by the motor. This reduction in power translates directly to savings for the customer on their electric bill.

The second benefit is in maintenance costs. There will always be maintenance costs associated with a system, but how often those maintenance costs hit can be reduce by the use of adaptive speed control. The faster you run something, the faster it is going to wear out. Unfortunately for mechanics this is normally the case on an exponential curve. Therefore the ability to slow the system down to only run as fast as needed helps bearings, belts, chains, sprockets, sorters, and many other components last longer. A good example to outline this is a 25 foot belt running at 400 feet per minute will roll around 8 times in that minute. While if that same belt was running at 200 feet per minute it would only roll around 4 times. That is half the movement and half the friction that the belt had to see. In addition, because this belt is run by a VFD, the splice on the belt does not see the high torque pull that a motor starter would produce at startup. Instead it sees a nice gradual acceleration to run speed.

The third benefit aids the employee's working conditions. When running a system at its full capacity it tends to generate a lot of ambient noise. By lower the speed of the system the ambient noise in the building is also reduced. This can reduce the need for earplugs to be used during low production runs or non-peak seasons. In general this also allows better communication for plant personnel around the system.

How to Quantify the Benefits

Quantifying the benefits for a given system is fairly difficult to due based on the fact that there is usually not a system in place that has historical data collected that it can be compared to. The best an integrator can do is developing small test cases that can be extrapolated into larger systems. For instance documenting the sound reduction of various pieces of equipment running and different speeds would allow a customer to better understand the effect that would have on their building. In similar fashion a documented case of a conveyor run using a VFD alongside a Conveyor Run with a motor starter could be developed and used to prove general power savings that could be seen and realized by the customer. In order to prove maintenance savings providing a case study that showed the duration of life cycle on a given part at different speeds such as a bearing could help illustrate how wear and tear is affected.

A lot of the understanding of these benefits come from the common sense realization of what speed inherently does to a system. By providing small case studies that can provide extrapolated concepts to larger systems, and integrator can help a customer understand the long term affects adding adaptive speed will have for his system.

How do you market adaptive speed?

Marketing from an integrators standpoint will always need to be approached from an up sell perspective. The material handling industry is extremely competitive and adding any extra cost into the base can cause the loss of a sale. The salesman needs to understand his customer and amount of capitol they are willing to put out up front on "Green" initiatives. An adaptive speed implementation can be tailored in many cases to various budget thresholds. An example of this would be that instead of have all the belts of a conveyor system adjust their speed, only consider adjusting the speed of key pieces of equipment such as high speed sorter and gapping systems. Once a customer begins to show interest in adaptive speed, helping them understand the long term benefits they will receive by lower cost of ownership is the next key to making the sale.

Conclusion

Adaptive speed systems are the current stage in material handling system design that allows customers to realize a lower system cost of ownership with consistent operation over time. They come with a higher initial up front cost. This tends to be a negative aspect when selling a job due to a company's accounting department. The short term upfront costs must be mitigated by the long term benefits. This can be difficult with system lifespans generally decreasing. In many cases the upfront cost can be mitigated by the sole benefit of reducing the systems power requirements. With energy costs constantly rising adaptive speed systems become more and more appealing. These systems when sold correctly up front produce extremely happy customers and help build long standing relationships.