Some thoughts on what drives the difference in potato storage air system design and operation philosophy between North American and European suppliers of equipment.

For some time now, I have been countering arguments in favor of European air system designs versus those used by my companies, Industrial Ventilation, Inc. (IVI) of Nampa, Idaho, USA and Teton West of Washington (TWW) of Pasco, Washington, USA. The evolution of US potato storage philosophy, I argue, represents the "best thinking" of potato storage managers in North America. Then, why, my customers ask, do the underlying systems differ so greatly? It is an unwritten maxim in this industry that you should not "bad mouth" your competition but, instead, point out the advantages and features of your company's equipment, service, and experience in the industry. However, potato storage design philosophy in Western Europe couldn't be more different than the common applications in North America. Evidence of the conflicting philosophies is easily demonstrated by the virtual non-existence of European storages in, say, the northwestern US (Idaho, Washington, and Oregon) and virtual non-existence of American storages in, say, England and Holland. So, surely, one of the two must be "right" and the other "wrong"? And, what are the implications for the expanding agricultural economies of Eastern Europe and China?

I do not profess to have all of the answers but I do hold some fairly strong opinions and I think I can defend my reasoning. Four large differences between European and North American potato storages come quickly to mind: 1.) Europe uses three times the "air" (per ton of stored product) of a typical American design, 2.) American potato storage management emphasizes humidity maintenance which is frequently only optional in European design, 3.) Large "bulk" piled potato storages dominate American farms versus frequent smaller "bin" storage applications in Europe 4.) American designs incorporate nearly continuous air circulation over each 24 hour storage day instead of the shorter "Midnight to 3 AM" European run-time.

Volume of Airflow

American storage design and operation is based on minimum volume of airflow of 20 CFM (cubic feet per minute) per ton of potatoes. Dutch design, I am told, is closer to 60 CFM per ton or three times the American design basis. A normal reaction to my proposals in Eastern Europe is that we are not providing near enough air flow for the: wet harvest conditions, heavy soils, potato varieties used, diseases present, etc. Well, that could be. Except, North Americans harvest in wet conditions and heavy soils, with diseased and sometimes frozen potatoes, and Eastern European varieties, I am told, are actually a more hardy variety (thicker skinned) than is commonly farmed in the US. What is left out of the comparison is the recommended round-the-clock run time of the US air system from the time the first potatoes are being loaded into the storage and up until outside air temperature conditions are well below storage set point for most of the day. I would maintain that a 20 CFM per ton air volume integrated over a 24 hour day provides much the same if not superior control for the drying and coddling of a newly harvested crop. Remember, besides being wet, the potatoes are trying to adjust to the stress of being "torn from the womb," so to speak, and are trying to settle into the new equilibrium of their storage location. The reassurance of a regular supply of oxygen and humidity and the immediate elimination of heat and carbon dioxide would make me feel better under the circumstances, much less a 5 meter pile of potatoes. It is not a time when I would want to hold my breath and pray for 12-18 hours.

But, you might ask, isn't this extended run time expensive... even at one third the horsepower of your fans? And considering the power payment penalties at peak hours? Well, the simple answer is "NO" because we typically pay less than USD 0.05 per kilowatt-hour, with no shortage of availability, and no peak hour surcharges if the system runs continuously instead of start-stop. Is that fair? Probably not, but similar energy cost conditions exist in Russia/Ukraine and why not take advantage of it?

Humidity Control

All US storage designs incorporate humidity control primarily through a large evaporative cooling element in the supply airflow called a Humidicell by IVI. Centrifugal disk humidifiers in the air plenum are used in a staging mode to top off the 90-95% RH Humidicell supply into the 98% range if a little free water is not of huge concern. Keeping storage humidity high in North American storages is considered of such importance that there is a substantial secondary market (remodels and replacements) for IVI 30 gallon per

hour disk humidifiers. It is considered crucial for effective wound healing and proper skin set. When the fans run, the humidity is on.....and the fans run all of the time! This is a significant difference between US and European thinking. I have been told that there is always natural high humidity in Holland. Perhaps, but, interestingly, a "Letter to the Editor" in last month's Potato Storage International from Johan Kikstra of Omnivent says clearly about a recent study "Where the humidity was, on average, higher....the stored potatoes showed as much as 60% fewer pressure bruises. However, the weight loss in the regulated bin was only 15% less when compared to potatoes stored without a humidifier." Oh, only a 15% weight difference. That's real money where I come from. Again, though, humidification only makes sense if the air is being circulated constantly. And, there are energy costs associated with running the humidifier motors. The humidicell pumps for recirculating water to the saturated cardboard media use much less energy, however, and the lack of free water and the multitude of incremental opportunities for evaporative cooling in the fall and spring cannot be ignored.

Bulk versus Bin Storages

It is probably unfair to categorize most Western European storages into the "Bin" category, but there are many of them. There are also a number of bulk storages in Europe. However, you would be hard-pressed to find a single potato bin storage in the Northwest US. And bulk storages in excess of 15,000 tons in the US, especially in the Columbia Basin area, are commonplace. I don't think that there is an argument over the preference for bulk storage in getting treated air to every potato. The middle potato in the middle bin in the center of a bin room is virtually starved of air. It will be the last potato to reach temperature (if at all) and then only through thermal conduction. Air systems are designed to pull warm air from the bin stack in such a room, refrigerate it and then distribute cold air across the top of the bin stack. This can only make sense in a retrofit situation to take economic advantage of an existing structure or in the case of limited real estate in a new construction scenario. The re-circulating air takes the path of least resistance which unfortunately is "around" the bins and not "through" them.

There is not much argument in the US that a properly insulated (spray-on polyurethane) quonset-style Behlen bulk potato storage with a Teton West patented internal fanhouse with Humidicell is the most economical storage per ton of stored product. There are literally miles of them in the US Northwest. Farmers build the biggest bulk storage that they can afford to reduce their price per ton cost based on textbook economies of scale calculations but limited usually by how quickly they can fill the storage. The rule of thumb is to size your storage to fill in 7-10 days so that the doors can be closed and the climate can be brought under computer control. (Harvesting equipment in North America is enhanced annually to increase harvest rates while minimizing handling damage allowing for ever larger storages.) The air system is carefully balanced to provide an even flow of air through a pressurized air plenum and distributed evenly under the 6 meter potato pile. Sometimes the top of the potato pile is even "raked" flat to provide smooth return air flow back to the fans and eliminate depression pockets where condensation could occur. US storage economics on a healthy crop only pencil out if storage shrinkage is held in the 5% range or less.

Incremental storage additions in the US are mainly in low population areas with massive amounts of relatively inexpensive land that is brought under irrigation. Most likely, this is a huge advantage over a more land-locked Western European farmer. Again, is it fair? Perhaps not, but which model best represents the enlarging farming operations in Eastern Europe? From what I can see, there is substantial opportunity for those farms to acquire or expand into available, inexpensive real estate.

Continuous versus intermittant run times

I have been told that European air systems are designed to run several hours at the coolest parts of the night in order to maintain desired pile temperature and generally without humidification addition. I suppose this is a gross simplification of these systems. It is also a simplification to describe most US systems as running continuously through every 24 hour storage day while trying to maintain 98% relative humidity. Both systems have an outside air throttling apparatus to control supply air to the potatoes during lower-than-pile outside air temperature opportunities. For comparing philosophies, let's use these simplistic descriptions. There are three benefits to continuous runtimes, in my opinion. First, the temperature delta from bottom to top most assuredly is better minimized and maintained with continuous airflow. If you will grant me that,

then, secondly, pile target temperature set point is easily chosen since the front to back and top to bottom temperature difference is minimal and a simple "lowest pile temperature" reading can be the control. In the intermittant case, the 21 hours of no airflow will allow pile temperature gradients to arise from top to bottom. To maintain an average desired target pile temperature, the bottom of the pile must be hit with colder temperatures when the system comes on than in the continuous scenario. This can lead to fry color problems and pressure bruise for the bottom potatoes. Third, in the intermittant scenario, there can be no question that the potatoes at best are "holding their breath" for 21 hours but at worst respiring in an ever increasing carbon dioxide environment which has also been shown to create color problems. Continuos run operation provides a regular carbon dioxide flush and oxygen supply.

European and North American storage philosophies have evolved differently over the years to meet the needs of a very demanding processing industry. Each has responded to local operating constraints and opportunities. In the emerging markets of Eastern European potato growers, it is not surprising that we have left many scratching their heads in wonder at the disparity in our philosophies. Will the solution be Either/Or or some hybrid of the two? Only time will tell.