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Cleaning at High Capacity

How Cleaning has changed in Canada

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Introduction Who Am I ?

- Managed Grain Terminal Upgrades (5 million bushel) in Saskatoon & member of design group for 21 terminals (SWP Project Horizon).
- Research & Development for upgrading byproducts from Oat & flour mills, Ethanol plants,
- Upgrades to Grain terminals, Canola Crushers, Pea fractionation.
- Spent 2 years in animal nutrition products & fish farm automation.
- Modifications to numerous export terminals across Canada, only a few that I have not worked in.
- Design work in Malt plants for all types of equipment and process changes.

Introduction, Who Am I 2

- 30+ years of grain handling, processing and cleaning experience.
- 14 years with building Grain Terminals, feed mills and expanding export facilities.
- Design & built an R&D pilot corn fractionation system (increase fermentable solids) Worked at ethanol plant during construction.
- Design & manufacture of grain cleaning and processing equipment (4yrs & part time to present).
- Designed dust control systems to NFPA requirements.

Grain Cleaning History 1

- Most cleaning was done with an aspirator with disc machines (1pth), then this changed to indents. Long & short separations. 1950-70's
- Seeds and broken were removed with indents as well. Crown & pinion or chain drives. Maintenance became an issue.

- Then reciprocating screen machines were used for seeds & broken and indents for longs removal.
- Indent drives were changed to cog tooth belt drives and downtime became minimal
- Capacity up to 130 mtph for 25 cylinder machines for long separation (heads and wild oats)

Grain Cleaning History 2

- Reciprocating screen machines that had mechanical brush drives were popular but brush drive were a maintenance issue.
- Rotary machines soon replaced most of the reciprocating machines.
- Cleaning removes FM Foreign Material. This FM can be processed to provide valuable products.
- Wheat heads are 70% good grain & 30% chaff, so fractionating aspirators and threshers were added to cleaning systems. Fractionating aspirators had multiple light discharges.

Grain Cleaning History 3

- Wild oats (MFO) market in PMU barns (Pregnant Mare Urine)For estrogen used in the production of the Pill.
- Width graders were installed to separate MFO from heads.
- Systems had separate indents, graders and then back to indents. We designed a COMBO that incorporates all functions into the same machine. Easier to install, internal spouting, one drive
- #1 Feed screenings was wheat chips and wild bucket wheat and was great for the chicken market. Price was close to wheat price.
- Round Up ready canola resulted in additional canola in the wheat dockage. Spirals were installed, most installs had issues with plugging. Incoming product was not prepared correctly.

Grain Cleaning History 4

- Canola a great cash crop but is a weed seed in cereals. Cereals also grow with the canola. Depending on what you are cleaning valuable products are in the screenings.
- Processing screenings meant multiple pieces of equipment complex flows & changing screens or separate reclaim systems.
- We developed a special flow rotary. Wheat/Mixed grain, off the top, with canola and fines separated to 2 lower decks for fines removal. Wheat chips from upper deck get cleaned on a small buck screen and around hole to produce a blendable for wheat and #1 feed screenings.
- Spirals are used, removing canola from broken wheat, cleaning canola removes large canola from buck wheat

Grain Cleaning History 5

- On primary machines Canola cleaning was done on 6.5 to 7 rd. hole screen sizes. Limited capacity, but was needed for high dockage canola (lots of buckwheat) Dockage at 5-8% was common.
- Round up ready canola resulted in a drastic drop in canola dockage and also reduced MFO's in wheat production in the next crop year.
- This allowed us to change to higher open area 7x7 mesh screens for cleaning canola at twice the capacity.
- China recently enforced a 1% dockage on Canadian Canola (dockage less broken deduct must be under 0.9%) (CGC rounds up)
- Typical broken deduct will be from 0.4 to 0.6%

Grain Cleaning History 6

- The combo machine combined indents and graders into one machine and provided a number of separations in one machine.
- The reclaim rotary them separated the recovered grains and screenings into byproducts and co-products
- Reclaim Rotary machines were developed to process canola and wheat cleaning in one step without changing screens. It also prepared canola from wheat screenings to be separated on spirals and reclaimed mixed grain from canola screenings. Flipping a number of manual valves allows for changing products in minutes.
- On primary rotary machines 6.5 to 7 rd. hole screen sizes limited capacity, (120 mpth) but was needed for high dockage canola (lots of buckwheat) Dockage at 5-8% was common.

Grain Cleaning History 7

- Canadian Grain Commission breaks down dockage into components and each type of dockage had a limit to meet export clean status.
- High Capacity Rotaries were installed in the US 20+ years ago as the FGIS grouped all the types of dockage into single FM number. From installations in the US work was done on getting wild oats to float off the end of the screens with some wheat & heads. Playing with screen sizes and machine throw for removing wild oat content became very efficient.
- Aspirators on rotaries were only a few inches wider than rotary screens and the quality of the air separation started to drop off above 7000 bph. 125 bph/in of width.
- It took a number of years, to get destoner/thresher into the US market despite having a very quick payback.

Grain Cleaning History 8

- In areas of North Dakota, wheat heads could be from 2 to 5% wheat heads and a few percentages of wild oats. Adding a few indents and a destoner/threshers could recover up to 3.5% wheat that was not paid for. Payback in one application was only 3 months.
- The PRIMARY rotarys would start to plug or have issues above 8000 bph.
- Original flat screen rotaries were 5 degrees and flow down the deck was only about 25 fpm. 7 degree rotaries were introduced and deck speed jumped to about 35 fpm.
- Most rotaries had parallel screen arrangements (screens parallel to the pan. Most applications were doing a scalp (larger over's) and a sift function (remove weed seeds and fines).

• Grain Cleaning History 9

- Changing the angle of the scalp allowed for more space at the feed inlet and more space on the clean discharge. The pan & sift screen were parallel and had plenty of space for fines flow.
- The next change was to change the angle of the decks/pans to 8 degrees. Now deck speed on the clean product jumped to 40 fpm.
- Wider aspirators increased equipment height and transitions were an issue. This also affect splitting of flow into inlet door (out of rubble deck).
- Twin aspirators were developed which was basically had 2 aspirators nose to nose, so flows greater than 14,000 bph were possible.
- This also simplified the product split from upper and lower shoes. One aspirator fed the top shoe an the second fed the lower shoe.

Grain Industry Changes 1

- Canola production in Canada was growing quickly & the introduction of Round-Up ready canola changed everything. Dockages dropped from 5-8% to 3-3.5% and buckwheat & MFO's have been reduced drastically. Areas that receive heavy rains during spraying periods still have higher buckwheat levels.
- (CWB) Canadian Wheat Board disappeared, opening up direct marketing. Registered wheat had to have a distinctive trait that could be recognized by inspectors disappeared. Some new wheat varieties 2x production increase.
- Shrinkage allowance at export facilities disappeared.
- Non-Commercially Clean (NCC) grains were now allowed to be shipped at export terminals

Grain Industry Changes 2

- New varieties of most commodities emerged on the market that had much higher yields.
- Round up ready canola in unsprayed wheat fields increased canola as dockage in wheat and cereal crops.
- Canola hit 1200$/tonne last year. Reclaims with spirals have good payback.
- Double core spirals cost 3k and can do about 35 bph. Incoming from wheat cleaning screenigs will be 10 to 20%. when canola gets back up to 1,100$ per tonne pay back would be 1 day. (additional of spouting could be minimal)
- With Canola dockage lower, the opportunity to open scalping screens sizes. 7x7 mesh can double the capacity of rotary cleaners.

Grain Industry Changes 2

- New wheat varieties emerged on the market that had much higher yields.
- Round up ready canola in unsprayed wheat fields increased dockage.
- Cleaning tariffs are made public in Canada and the industry average is 5.21/tonne (0.14/bu) for wheat. Canola cleaning tariffs at 6.29/tonne. (0.143/bu)
- With Round up ready canola & wheat rotation, wild oats dockage in wheat has been reduced.
- PMU barns replaced by synthetic estrogren. MFO's market is limited & as is the supply of MFO's (Mixed Feed Oats)
- China changes to <1% dockage in canola (Dockage minus broken deduct)

New Cleaner Flows Emerging 1

- 20-30 years ago there was a huge expansion in the concrete inland terminal numbers.
- With increase production there are still a number of terminals being built in some areas.
- There are a number of elevators that no longer use indent cleaners in the primary cleaner flows. Single primary rotaries with large aspirators and higher capacities 300 mtph (11,000 bph), with a small reclaim to reprocess over's and screenings.
- 11,000 bph at 0.14/bu is 1540$/hr.

New Cleaner Flows Emerging 2

- There are a number of flows out there where screen selection, allows for cleaning multiple commodities without changing screens. Wheat, peas, barley are common.
- With some modifications and trials, I believe we will get to add canola and red Lentils into this one design for all.
- Indents need Major overhauls every 5-8 years depending on handle. Rotaries typically run until fatigue takes over (more than 30 years)
- Plants using primary indents can be running 44 indent cylinders (36 primary & 8 reclaim) for 160 tph. New flows will have 8 indents and run at 270-300 tph.
- Rotary life cycle replacement should be planned around 30 years.
- The first round of concrete slips are getting to this age. (130-160 mpth)

New Cleaner Flows Emerging 3

- Owners should look at advantages to making changes to their cleaner flows. Not all applications can be best served with existing equipment designs.
- Recently a Dual aspirator (not a twin) to meet a customer's application was designed. The aspirator pulls very hard at the infeed lifting some good product. The settling chamber has been modified to become a second aspiration with slower velocities to pull the fines and dust to the bag house. Reclaim product comes out the air lifting's screw. Units being installation underway. In this case, there was no reclaim system and the graders below aspirator only kicks out large dockage.
- Top cleaner 450 mtph 16,500 bph sift only
- Lower cleaner 270 mtph 10,000 bph scalp & sift

Custom Designed Equipment & Flows

- Custom designed equipment costs more, but if it gets the product clean at high capacity it is likely worth the extra cost.
- I like to play and I was working on cleaning flax. (normally very slow as it lays flat on a screen and does not tip up well to pass thru the scalp wire mesh.) I had a custom drum grader shell built with tribar wire. The flax could not bridge across the peaks, so it tipped and out the slot. The capacity was about 10 times higher than a flat screen cleaner. (tph/sqft) The clean had no canola in it.
- Designing for high capacity can be a challenge, but one has to be aware that a lot of new cleaning systems can exceed the capacity of the existing legs and drags taking product to storage. The past design will not handle the new flow rates, so the cleaners and bulk handling needs to be addressed in the same budget process to benefit from the upgraded cleaning process.

My Personal Projections

- Canola Crushers are expanding & new builds are being planned.
- Canola acreage seems to be expanding every year and will continue.
- Canola will still have a significant export program even with new crushers coming online in the next few years.
- Flexibility to change products quickly will be an advantage.
- A number of cleaners presently operating now are nearing end of life cycle.
- Review of past cleaner flows to reduce total operational costs is justified.
- This technology could be marketed around the world.
- Feeding the world as we move to 10 billion people will be a challenge.

What can be done with Grain Screenings

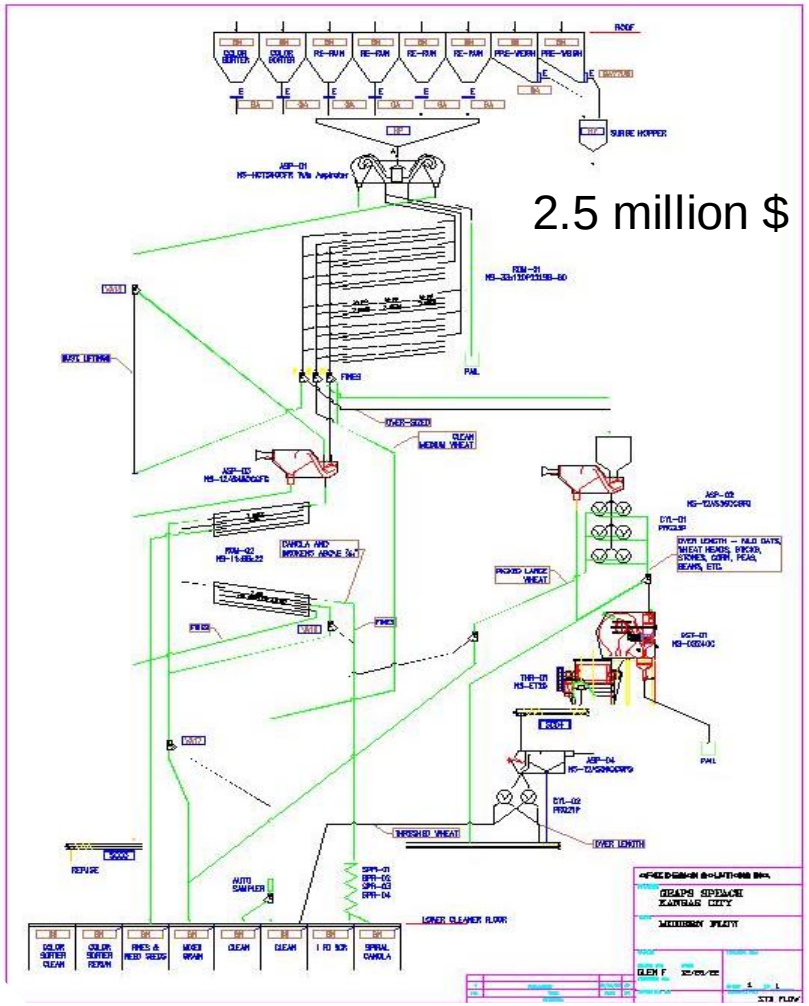
- Cattle producers often do not like to feed screenings due to the high weed seed content that goes un-digested and weeds grow when the manure is spread on the fields. Composting for a year addresses this issue but manure needs to be handled twice.
- 350 Animal Nutrition class at U of S, we came up with 5 rations and fed sheep. Raw screenings, ammoniated screenings, aspirated & ground in HM with small rd hole. Aspirated, ground and ensiled screenings.(AGE)
- Fecal material was collected, broken down aspirated and put on damp cloth to allow growth. Most rations had significant growth. AGE process had no growth. The students call that group of sheep “pigs” as gains were 2-4 times more than other rations. Conversion was much higher.
- Feed mills use screenings as carriers for adding other nutrients to calf pellet rations.

USA Cleaning Changes Coming?

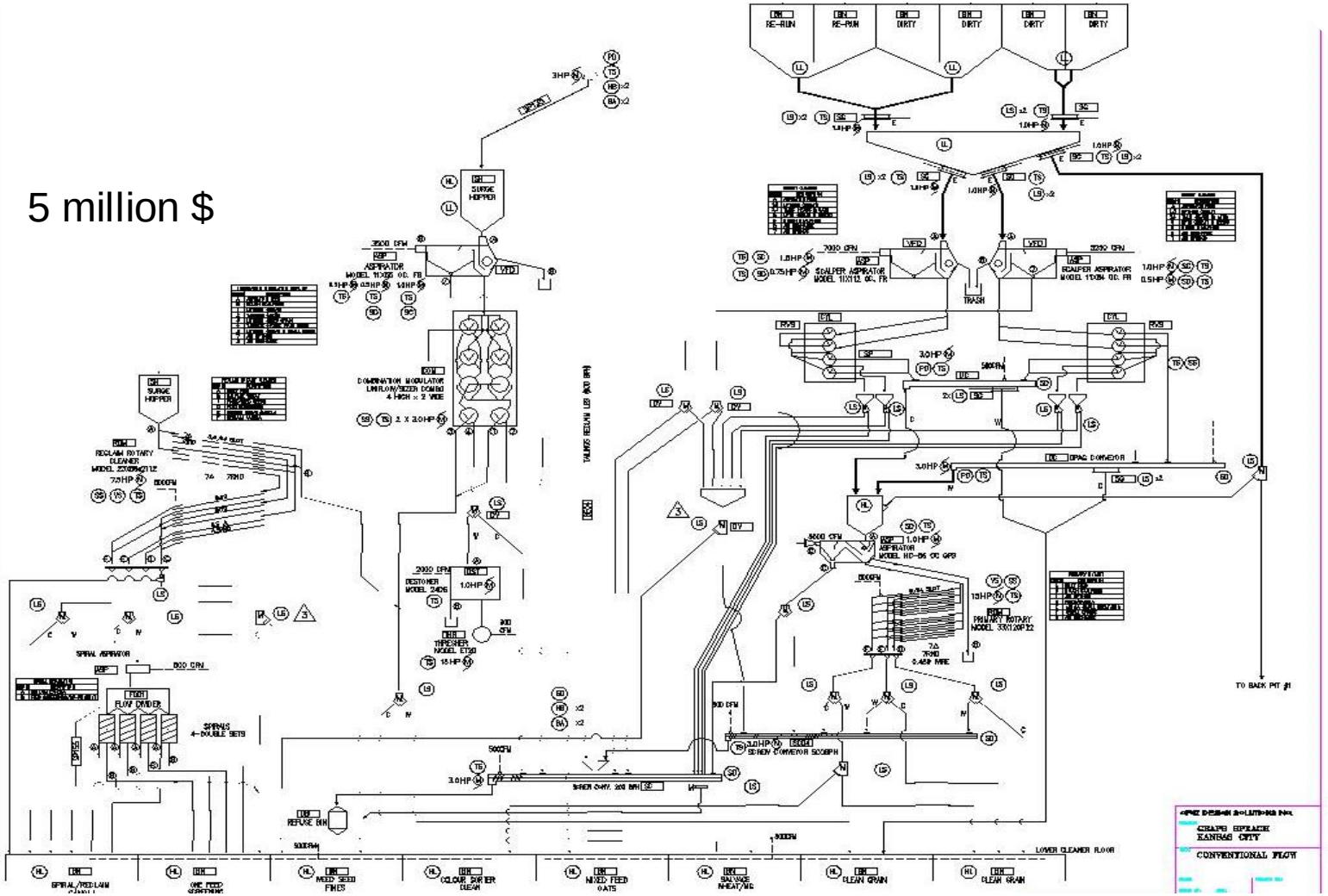
- US production 14 BB/yr corn, 4BB/yr wheat, 1.6 BB/yr wheat.
- Soybeans to China as of 2018 <1% FM, ½ of 27.5 Million tonnes did not make this grade.
- China looking for cleaner products across the board (Canola Canada)
- Clean Wheat exports have been increasing (number to cleaners being installed in delivery terminals).
- Corn may require cleaning for certain markets in the future.
- Cleaners maybe required for a greater portion of the US production in the future.

Cleaner Flows Estimated Install Costs

2.5 million $



5 million $



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