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Evaluation Report 440

Conveyair I Pneumatic Grain Conveyor

A Co-operative Program Between
ALBERTA FARM MACHINERY RESEARCH CENTRE
PAMI
PRAIRIE AGRICULTURAL MACHINERY INSTITUTE

CONYEYAIR I PNEUMATIC GRAIN CONVEYOR

MANUFACTURER:

Vana Industries Ltd.
92 De Baets Street
Winnipeg, Manitoba
R2J 3S9

DISTRIBUTORS:

Frank Flaman Sales Limited -- Edmonton, Alberta
-- Saskatoon, Sask.
-- Prince Albert, Sask.
-- Southey, Sask.

RETAIL PRICE:

$14,740.00 (June, 1985, f.o.b. Lethbridge, Alberta), complete with cleanup nozzle, full bin nozzle, poly hose and flexible steel line.

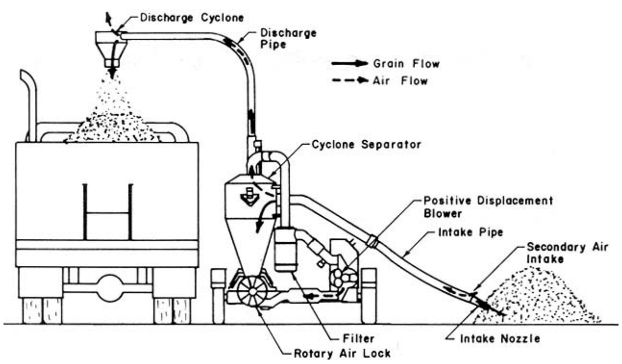


FIGURE 1. Schematic View Showing Air and Grain Flow.

SUMMARY AND CONCLUSIONS

The maximum conveying rates obtained with the Conveyair were 2590 bu/h (70.4 t/h) for wheat, 3170 bu/h (69.1 t/h) for barley and 2090 bu/h (47.4 t/h) for canola. Conveying rates were reduced when intake or discharge pipe lengths were increased.

Power requirements while conveying grain varied from 61 to 78 hp (45.5 to 58.2 kW). A tractor with maximum power take-off output of at least 90 hp (67.2 kW) was required to overcome peak power requirements.

The specific capacity (the amount of grain moved per unit of power in a specific period of time) of an average 8 in (200 mm) diameter grain auger was four and one-half times greater than that of the Conveyair I in wheat and three and one-half times greater in canola. This indicates that pneumatic conveying of grain is inefficient in terms of power required for the amount of grain moved when compared to a grain auger. However, Pneumatic conveyors have advantages a grain auger doesn't have. For exarnple, they are capable of conveying grain over longer distances, both vertically and horizontally, than is possible with a grain auger.

Crackage in dry wheat was less than 0.2% for each pass through the Conveyair I. This is similar to damage caused by grain augers. However, observations indicated that crackage was high in dry canola. Passes through the machine should therefore be kept to a minimum.

The optional 4 in (100 mm) diameter intake and polyethylene hose made bin clean-out very easy. The discharge cyclone could be conveniently removed or attached when the discharge boom was lowered.

The Conveyair I was much safer to use than a grain auger, especially for cleaning grain bins. Working near the inlet nozzle was clean as most dust was conveyed into the inlet. It was also safer than an auger since the operator was exposed to fewer moving parts. Noise levels adjacent to the coriveyor varied from 96 to 106 dBA when operating in open areas. When operating close to metal bins the noise level was loud and irritating. It is recommended that an operator wear suitable ear protection when working near the Conveyair I.

Several mechanical failures occurred during the test. The main blower shaft failed and the seals on the folding discharge boom failed.

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Supplying a clamp to prevent the seal on the folding discharge boom from separating when operating at peak capacities.
2. Supplying guidelines for the secondary air settings required for conveying various grains.
3. Investigating increasing the size of the secondary air opening, located above the filter, to increase conveying capacities.
4. Modifications to provide for easier air lock speed adjustment within the recommended operating range.
5. Manufacturing the discharge cyclone out of more durable material.
6. Supplying a filter that effectively filters canola and grain dust.
7. Moving the slow moving vehicle sign so that it is not obstructed from view by the discharge boom when in transport position.
8. Modifications to the seals on the folding boom discharge to prevent seal failure.

Senior Engineer: E. H. Wiens

Project Engineer: L. W. Papworth

THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. The boom no longer separates when operating at peak capacities since the location of the hinge points have been changed.
2. Guidelines for the secondary air settings for conveying various grains would not be practical since conditions of the material and the conveying distances vary greatly.

   Page 9 of the operators manual provides these guidelines for secondary air settings (under start-up): "Open airslide on intake nozzle approximately 2 inches. Insert intake in grain. To achieve maximum capacity, adjust airlock speed to allow grain level inside the receiver tank to stay at the level of the inspection door. Then slowly close the airslide to about 1/2" - 1".
3. Further studies are being conducted to determine whether increasing the size of the secondary air opening located above the filter will increase conveying capacities for !ong distance blowing.
4. Airlock speed adjustment has not been a problem. If the hydraulic flow on the tractor is opened too far the adjustment is more difficult.
5. A high grade of nylon is now used to manufacture the discharge cyclone. In addition, double replaceable wear liners are now installed on the nylon discharge cyclone.
6. Deflector plates are now installed in addition to the patented double separation filtering system, resulting in greatly increased filtering performance of dust, fines and canola. It has been proven to be not practical or economical to filter all dust. The purpose of the Conveyair's external filter is to protect the pump from seizing up in case of plugging, and to protect it from stray grain kernels.
7. The slow moving vehicle sign will be moved so as to be in clear view when towing.

8. An improved adhesive is now used on the boom seals to prevent movement of boom seals.

MANUFACTURER'S ADDITIONAL COMMENTS:

1. The Conveyair I tested was a 1984 model. In 1985 this machine is designated as the Conveyair 3000.
2. The failure of the blower shaft was considered a "freak" due to a hidden fault in the blower as supplied by the blower manufacturer. This fault has now been corrected. The Schwitzer blower is a widely sold, high quality pump.
3. A shoulder strap is now supplied as a standard feature for further ease of operation of the cleanup nozzle.

GENERAL DESCRIPTION

The Conveyair I is a 1000 rpm, power take-off driven pneumatic grain conveyor, mounted on a two wheel trailer. The positive displacement blower (FIGURE 1) provides both suction and discharge air to convey grain without passing it through the blower. Grain is conveyed by the intake airstream through the intake nozzle where it is drawn into the cyclone separator. The grain is then separated from the air and the air is drawn through a filtering system to the blower. The grain passes through the rotary air lock into the discharge airstream of the blower, which delivers it to the discharge cyclone.

The blower is driven from the power take-off shaft by 5 V-belts. The rotary air lock is driven by a hydraulic motor from the tractor remote hydraulics. A hydraulic control panel for varying air lock speed and for raising and lowering the discharge boom is located on the side of the conveyor.

Intake and discharge locations can be varied by adding sections of rigid or flexible pipe. The 5 in (125 mm) diameter discharge pipe is available in both rigid and flexible steel. The 5 in (125 mm) diameter intake pipe is available in rigid steel, flexible steel and polyethylene, while the optional 4 in (100 mm) diameter intake is available in rigid steel and flexible polyethylene.

FIGURE 1 shows the location of major components while detailed specifications are given in APPENDIX 1.

SCOPE OF TEST

The Conveyair I was used for 19.0 hours to convey the various grains shown in TABLE 1. It was evaluated for ease of operation and adjustment, rate of work, power requirements, quality of work, operator safety and suitability of the operator's manual.

TABLE 1. Operating Conditions.

MATERIAL	QUANTITY CONVEYED bu	(t)	HOURS
Spring Wheat	11,370	(309.5)	11.5
Canola	3,925	(89.0)	3.0
Barley	3,810	(83.0)	3.5
Rye	495	(13.5)	1.0
TOTAL	19,600	(495.0)	19.0

RESULTS AND DISCUSSION

EASE OF OPERATION AND ADJUSTMENT

Standard Discharge: The standard discharge (FIGURE 2) consisted of one short radius 90° elbow and a folding boom, to which the discharge cyclone was attached. The boom could rotate 180 degrees and be locked in position every 15 degrees. This assembly was designed as a truck loading kit. The 12 ft (3.6 m) discharge height and 6.2 ft (1.9 m) reach were insufficient for filling grain bins but easily accommodated all common truck box heights.

The discharge cyclone should be removed when transporting long distances or over rough ground. The 40 lb (18 kg) discharge cyclone was easily attached or removed since the discharge boom could be conveniently lowered and raised hydraulically.

When run at maximum capacities, the Conveyair I would occasionally surge. This surging would force the seal on the folding discharge boom to separate and grain to blow out. It is recommended that the manufacturer consider supplying a clamp to prevent the seal on the folding discharge boom from separating when operating at peak capacities.

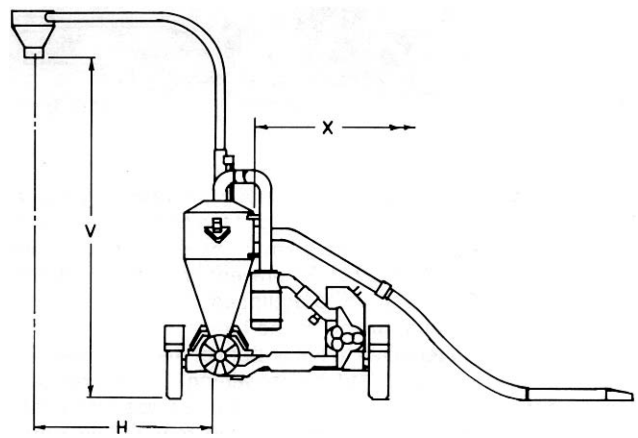


FIGURE 2. Standard Discharge Assembly: V = 12.0 ft (3.6 m), H = 6.2 ft (1.9 m).

Conveying Pipes: Rigid steel tubing sections in various lengths and flexible steel hose in 10 ft (3 m) and 3.5 ft (1.1 m) lengths were available to change inlet and discharge distances. Both the rigid tubing and flexible hose were 5 in (125 mm) diameter. A 5 in (125 mm) diameter, 14 ft (4.2 m) polyethylene hose was also supplied for use during bin clean-out, with an optional 4 in (100 mm) diameter, 14 ft (4.2 m) polyethylene hose also available to further ease the clean-out operation. Pipes were joined using quick couplers or bolted clamp connectors. All joints, which were sealed with either rubber "O" rings or wide rubber gaskets, were air tight.

Intake Nozzles: Two types of 5 in (125 mm) diameter intake nozzles were available (FIGURE 3). The straight steel intake nozzle was used for normal grain conveying. It was awkward to handle due to its 7.3 ft (2.2 m) length and 29 lb (13 kg) weight, but was very durable and effective for general conveying. The 5 in (125 mm) diameter aluminum intake nozzle (FIGURE 3) was used with the 14 ft (4.2 m) polyethylene hose during bin clean-out. The nozzle was fairly easy to maneuver so complete bin clean-out could be accomplished.

A 4 in (100 mm) diameter aluminum intake nozzle was also available, as an option, to use with the 4 in (100 mm) diameter polyethylene hose. This set-up had less capacity than the 5 in (125 mm) system but was much easier to maneuver during bin clean-out. The reduction in capacity from 1590 bu/h (43.3 t/h) for the 5 in (125 mm) system to 1260 bu/h (34.3 t/h) for the 4 in (100 mm) system, was worth the further ease of operation of the 4 in (100 mm) set-up during clean-up of bin floors.

Both clean-out nozzles came with flared ends (FIGURE 4) that increased the suction area of the nozzle. They were very effective during bin floor clean-up.

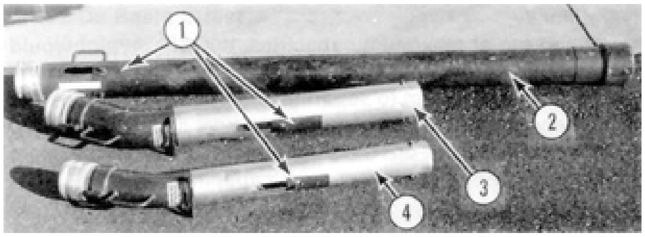


FIGURE 3. Intake Nozzles: (1) Adjustable Slide, (2) 5 in (125 mm) Diameter Steel Nozzle, (3) 5 in (125 mm) Diameter Aluminum Nozzle, (4) 4 in (100 mm) Diameter Aluminum Nozzle.

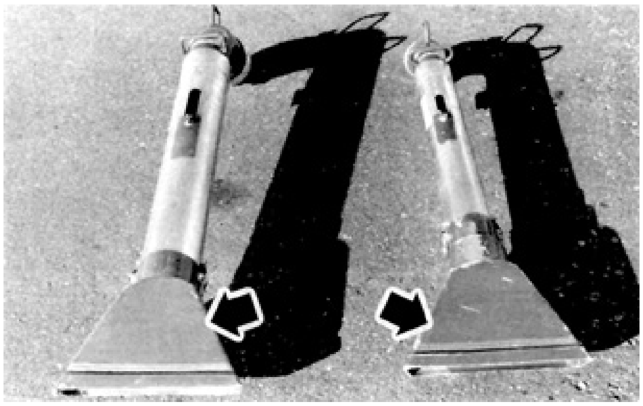


FIGURE 4. Flared Ends on Intake Nozzles

Filtering System: Because of close tolerances, positive displacement blowers require filtering of the conveying air after it has been separated from the grain in the separator cyclone and before it enters the blower. To prevent grain from entering the blower, the Conveyair I was equipped with a screen filter (FIGURE 5) located just ahead of the blower.

The filtered material fell to the bottom of the filter. The filter could be easily cleaned out by loosening a wing nut and removing the bottom cover. The filter element was also easily removed by loosening a threaded nut, but required very little cleaning during normal operation.

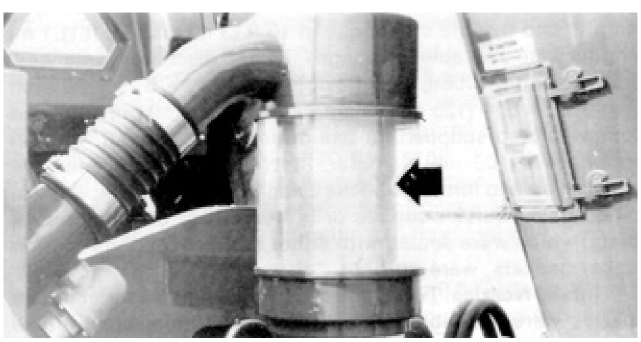


FIGURE 5. Filter

Transporting: The truck loading kit could be easily placed in transport or field position by one person. The discharge boom was conveniently lowered or raised with the hydraulic cylinder from the control panel (FIGURE 6). The discharge cyclone could be conveniently removed or attached when the discharge boom was lowered. The discharge boom was mounted in the saddle provided for transport (FIGURE 7). Caution had to be exercised while raising or lowering the boom because of the close proximity of the boom to control panel operator.

The Conveyair was very compact and stable in transport position but the manufacturer recommended a maximum towing speed of only 20 mph (33 km/h). The reason for this was that the machine was equipped with implement tires.

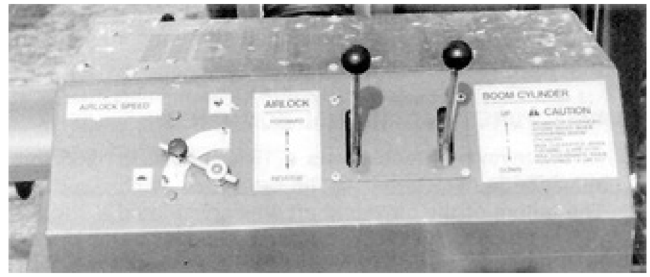


FIGURE 6. Control Panel.

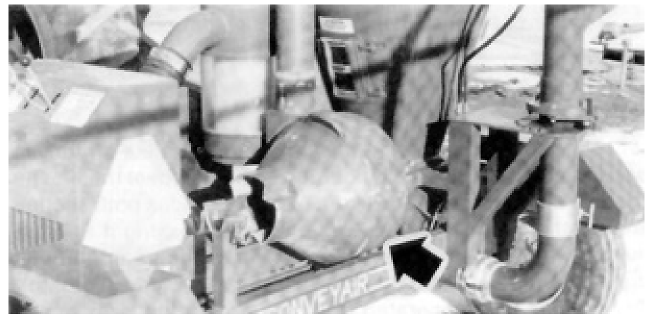


FIGURE 7. Discharge Cyclone Mounted in Transport Saddle.

Hitching: The Conveyair I was easily hitched to tractors with a 1000 rpm power take-off. The hitch jack was convenient. The hitch clevis was not adjustable to suit varying tractor'drawbar heights. Consequently, the conveyor could not be adjusted to operate level with all tractors used.

Adjustments: The blower drive belts were adjusted and aligned by two threaded bolts located on each side of the main drive pulley. Care was taken when aligning so the pulleys were within the manufacturer's tolerance of 1/16 inch (1.6 mm).

The speed of the air lock could be adjusted from 0 to 180 rpm by adjusting a hydraulic flow control valve with a lever located on the control panel (FIGURE 6). The secondary air flow could be varied with the adjustable slides provided on the intake nozzles (FIGURE 3) and also with the adjustable slide above the filter (FIGURE 8).

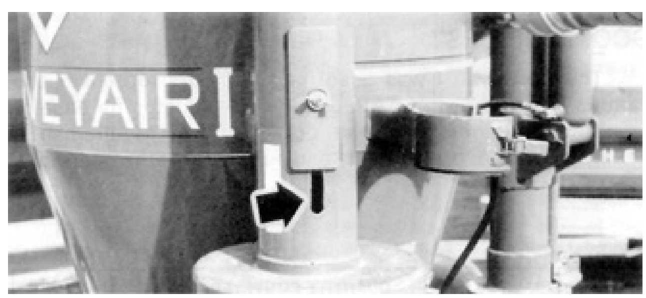


FIGURE 8. Secondary Air Opening Located Above Filter.

Servicing: The Conveyair I had nine grease fittings and two gear boxes to service. Servicing took about 10 minutes. The operator's manual recommended various lubrication schedules for the grease fittings and the gear boxes. All service points were easily accessible. The blower gear boxes were equipped with oil level sight glasses for convenient checking of the oil level.

RATE OF WORK

Maximum Conveying Rates: Conveying rates for the Conveyair I depended on the type of grain being conveyed, speed of the rotary air lock, secondary air settings and length of intake and discharge pipes.

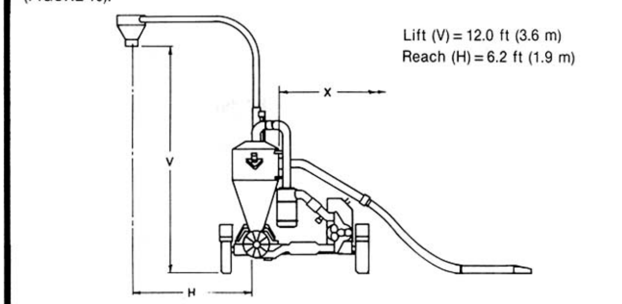
The conveying rate was very dependent on maintaining a steady flow rate. Highest conveying rates were obtained when the intake nozzle was completely submerged in grain, using the steel intake pipe and the standard discharge assembly (FIGURE 2). As shown in TABLE 2, the maximum conveying rates were 2590 bu/h (70.4 t/h) in wheat, 3170 bu/h (69.1 t/h) in barley and

2090 bu/h (47.4 t/h) in canola. The wide range of conveying rates in TABLE 2 indicates the difficulty in adjusting the secondary air openings and rotary air lock speed to obtain maximum conveying rates.

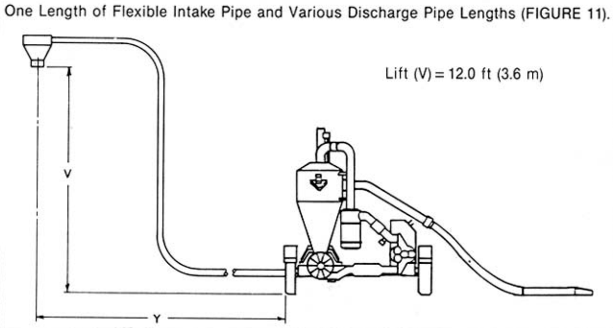
For wheat and canola the maximum capacity was limited by the amount of grain the airlock could pass. In barley the maximum capacity was limited by available air flow.

TABLE 2. Conveying Rates at 1000 rpm Power Take-Off Speed.

With Standard Discharge Assembly (FIGURE 2) and Various Intake Pipe Lengths (FIGURE 10).



One Length of Flexible Intake Pipe and Various Discharge Pipe Lengths (FIGURE 11).



GRAIN	INTAKE PIPE LENGTH (X)			DISCHARGE PIPE LENGTH (Y)	
	10 ft (3.1 m)	50 ft (15.2 m)	100 ft (30.5 m)	50 ft (15.2 m)	100 ft (30.5 m)
Wheat	2300-2590 bu/h (62.6-70.4 t/h)	1600-1770 bu/h (43.7-48.2 t/h)	1300-1400 bu/h (35.3-38.2 t/h)	1190-1315 bu/h (32.3-35.7 t/h)	1090-1225 bu/h (29.6-33.4 t/h)
Barley	2855-3170 bu/h (62.1-69.1 t/h)		1940-2090 bu/h (42.2-45.6 t/h)		1585-1770 bu/h (34.5-38.5 t/h)
Canola	1875-2090 bu/h (42.6-47.4 t/h)		1880-1990 bu/h (42.7-45.1 t/h)		1330-1515 bu/h (30.1-34.3 t/h)

Secondary Air Setting: The amount of secondary air introduced at the intake nozzle was important in obtaining maximum conveying rates. Too little secondary air caused the conveyor to surge. Too much secondary air resulted in inefficient conveying due to reduced suction at the intake. The secondary air setting depended on the density of the material being conveyed and length of conveying pipe. Optimum secondary air settings had to be established by trial and error for each grain conveyed. For example, the optimum setting for wheat, using the standard intake and discharge assembly, was determined to be 1.25 in (31.25 mm) (FIGURE 9), which resulted in a conveyi.ng rate of 2590 bu/h (70.4 t/h). It is recommended that the manufacturer provide similar guidelines for secondary air settings for all grains. A numbered scale adjacent to the adjustable slide would also be very useful as a reference for the operator.

As already mentioned, the Conveyair I had two secondary air openings. The purpose of the second opening, located above the filter (FIGURE 8), was to cool the blower and increase capacities when discharging long distances. The opening worked very well and did increase capacities when discharging grain long distances. Maximum capacities, with extended discharge lengths, were obtained with the secondary air opening wide open. The opening was also used wide open when conveying canola with the standard intake and standard discharge. Because the optimum setting was wide open for extended discharge lengths, it is recommended that the manufacturer investigate increasing the size of the opening. The optimum setting for extended intakes was found to be in the completely closed position. However, if opened, the extra opening served to cool the blower.

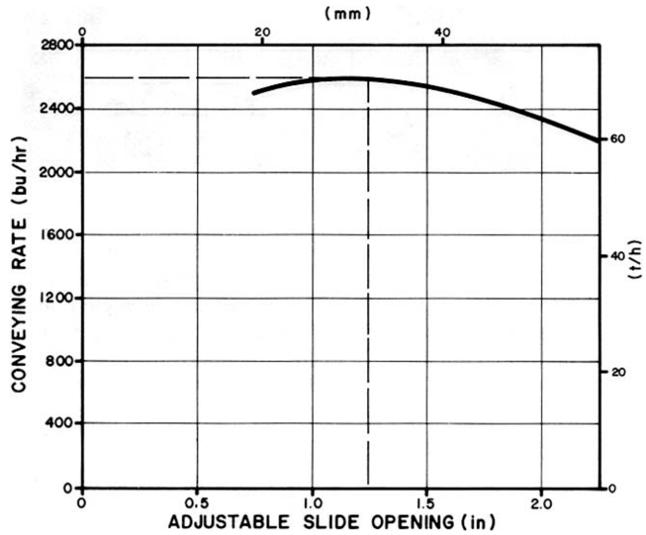


FIGURE 9. Conveying Rates in Wheat for Various Secondary Air Openings.

Air Lock Speed: Recommendations for air lock speed were given in the operator's manual for wheat and barley. The range of speeds provided, resulted in maximum conveying rates. Too slow an air lock speed resulted in the separator cyclone plugging. Too fast an air lock speed reduced capacity and could also cause separator cyclone plugging due to improper feeding of the air lock.

Air lock speed was very hard to adjust. The air lock speed adjustment ranged from 0 to 180 rpm. Consequently, the optimum recommended range of 50 to 60 rpm allowed for only very small changes in the location of the control lever (FIGURE 6). It is recommended that the manufacturer make modifications to provide for easier air lock speed adjustment within the recommended operating range.

Discharge Cyclone: The discharge cyclone provided was manufactured out of plastic. Consequently, it cracked easily during testing, especially in cold weather. It is recommended that consideration be given to manufacturing the discharge cyclone out of a more durable material.

Effect of Pipe Length: Conveying rates decreased with increased intake pipe length. For example, increasing the intake pipe length from 10 to 100 ft. (3.1 to 30.5 m) (FIGURE 10) reduced the maximum conveying rate from 2590 to 1400 bu/h (70.4 to 38.2 t/h) in wheat, from 3170 to 2090 bu/h (69.1 to 45.6 t/h) in barley and from 2090 to 1990 bu/h (47.4 to 45.1 t/h) in canola.

Increasing the discharge length also reduced the conveying rate. The standard discharge boom had a reach of 6.2 ft (1.9 m). Increasing the discharge length to 100 ft (30.5 m) (FIGURE 11) reduced the conveying capacity in wheat from 2590 to 1225 bu/h (70.4 to 33.4 t/h), in barley from 3170 to 1770 bu/h (69.1 to 38.5 t/h) and in canola from 2090 to 1515 bu/h (47.4 to 34.3 t/h).

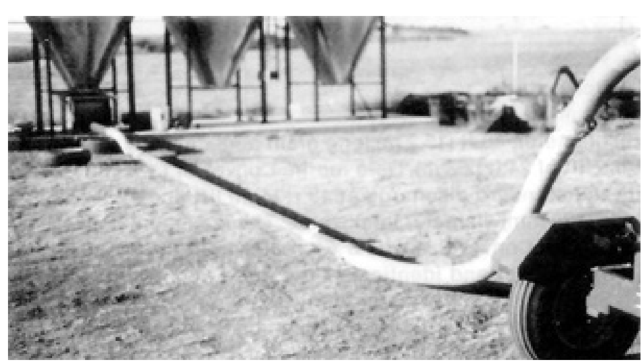


FIGURE 10. Increased Intake Pipe Length.

FIGURE 11. Increased Discharge Pipe Length.

Effect of Pipe Type: Conveying rates decreased when the polyethylene clean-out hoses were used as opposed to the steel tubing or the flexible steel pipe. The maximum conveying rate in wheat decreased from 1770 bu/h (48.2 t/h) for the rigid intake to 1590 bulb (43.3 t/h) for the 5 in (125 mm) polyethylene clean-out hose and to 1260 bu/h (34.3 t/h) for the 4 in (100 mm) polyethylene clean-out hose. Capacities for the polyethylene clean-out hoses for wheat, barley and canola are given in TABLE 3.

TABLE 3. Conveying Rates for Polyethylene Clean-Out Hoses.

GRAIN	14 FT (4.2 m) POLYETHYLENE HOSE	
	4 in (100 mm) diameter	5 in (125 mm) diameter
Wheat	1110 to 1260 bu/h (30.2 to 34.3 t/h)	1330 to 1590 bu/h (36.1 to 43.3 t/h)
Barley	1480 to 1675 bu/h (32.3 to 36.5 t/h)	1990 to 2240 bu/h (43.4 to 48.7 t/h)
Canola	1435 to 1600 bu/h (32.6 to 36.3 t/h)	1690 to 1900 bu/h (38.4 to 43.1 t/h)

Filtering System: The filtering system was effective in filtering grain kernels out of the air stream but all grain dust and canola were not filtered. At high conveying rates with canola, canola seeds entered the air supply to the filter, causing the filter to plug (FIGURE 12). The filter element had to be removed and cleaned because the canola was lodged in the holes of the element. To avoid canola seeds plugging the filter, conveying rates had to be closely controlled and monitored. It is recommended that the manufacturer consider providing a filter that effectively filters canola and grain dust.

FIGURE 12. Filter Plugged with Canola.

Comparison to a Grain Auger: TABLE 4 compares the performance of the Conveyair I to that of an average 8 in (200 mm) diameter, 50 ft (15.2 m) long grain auger at 30° inclination with a lift of 24 ft (7.3 m). Data for the Conveyair I was obtained with the standard discharge at 13 ft (4 m) lift and 12 ft (3.7 m) of 5 in (125 mm) diameter intake pipe. The maximum conveying rate for the Conveyair I was 8% greater than the grain auger in spring wheat and identical to the grain auger in canola.

Specific capacity (the amount of grain moved per unit of power in a specific period of time) can be used to compare the two methods of grain handling. High specific capacity indicates efficient use of energy while low specific capacity indicates inefficient energy usage. The specific capacity for the grain auger was about four and one-half times greater than that of the Conveyair I in wheat and about three and one-half times greater in canola. This indicates that pneumatic conveying is inefficient as compared to augering grain. However, pneumatic conveyors have advantages that grain augers do not have. They are capable of conveying grain over longer distances, both vertically and horizontally, than is possible with a grain auger. Pneumatic conveyors are also safer to operate than grain augers.

TABLE 4. Comparison of the Conveyair I to an Average 8 in (200 mm) Diameter Grain Auger[1]

CONDITION	MAXIMUM CONVEYING RATE				SPECIFIC CAPACITY			
	CONVEYAIR I		GRAIN AUGER		CONVEYAIR I		GRAIN AUGER	
	bu/h	t/h	bu/h	t/h	ton/hph	t/kwh	ton/hph	t/kwh
Wheat	2590	70.4	2393	65.3	1.16	1.41	5.1	6.2
Canola	2090	47.4	2087	47.3	0.85	1.03	2.9	3.4

POWER REQUIREMENTS

The maximum power take-off input was 78 hp (58.2 kW) when the conveyor was operating at maximum capacity in barley (FIGURE 13). This compared to a power requirement of 16 hp (12 kW) when moving air only with the positive displacement blower equipped Conveyair I. Power input depended on the type of material being conveyed. The heavier the material, the more resistance to flow the material had and the greater the power required. At maximum conveying rates, power requirements were 78, 68, 61 hp (58.2, 50.7 and 45.5 kW) for barley, wheat and canola, respectively.

A minimum tractor size of 90 hp (67.2 kW) was required to overcome peak power requirements. Peak power requirements occurred when the machine was on the verge of plugging.

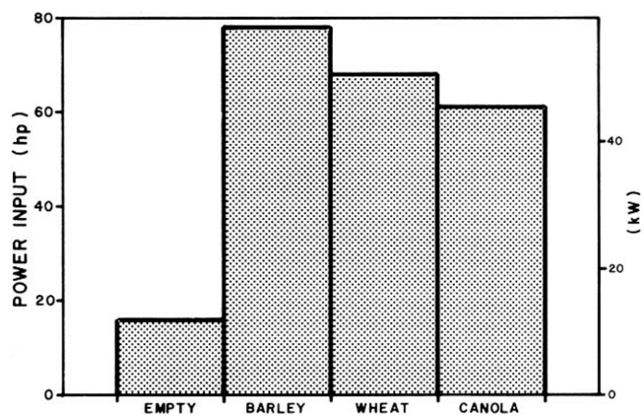


FIGURE 13. Power Requirements at Maximum Conveying Rates.

QUALITY OF WORK

Grain Damage: FIGURE 14 shows the increase in grain crackage each time a sample of dry wheat (12.5% moisture content) was conveyed. In these tests, the Conveyair I was equipped with the standard discharge assembly (FIGURE 2) and the steel intake pipe. The wheat initially contained 0.8% cracks. Each pass through the Conveyair I caused an average of 0.2% increase in crackage. This indicates that if the number of passes is kept to a minimum, grain damage should not be a problem. Test results from grain augers in dry wheat have shown that each pass through an auger causes less than 0.2% crackage.

Laboratory tests were not performed on the crackage caused by the Conveyair I in canola. However, field observations indicated that the damage was considerable if the sample was dry. When using the Conveyair I to convey dry canola, the number of passes through the machine should be kept to a minimum.

Plugging: Plugging could occur in the intake line if insufficient secondary air entered the nozzle to carry the material

[1] Grain auger data represents average data results from Machinery Institute Test Reports 319, 320, 321.

being conveyed. Proper adjustment of the secondary air intake prevented plugging of the intake line.

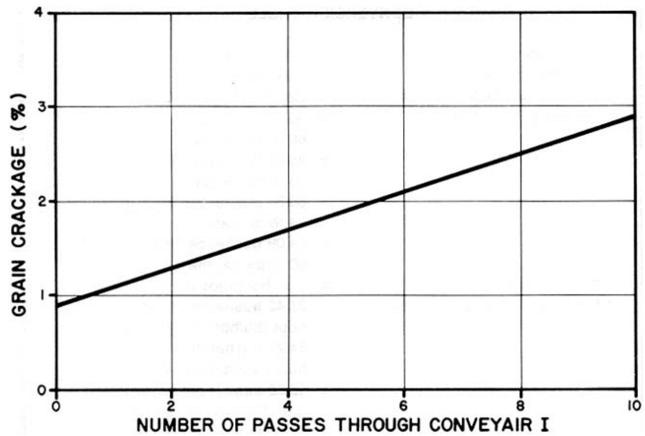


FIGURE 14. Grain Crackage in Dry Wheat.

Plugging of the cyclone separator occurred if the air lock speed was too slow or too fast and also if more grain was taken in than the air lock could pass. Coordinating the secondary air setting and the air lock speed prevented the cyclone separator from plugging. Unplugging of the cyclone separator or the intake line could be accomplished by discontinuing grain intake and allowing air to clear the blockage. The filter would also plug after the cyclone separator had plugged. To clear the filter, the bottom cover had to be removed as described earlier.

Plugging of the discharge line could occur when longer lengths of pipe were used. To prevent damage, to the blower, the Conveyair I was equipped with a pressure relief valve and a vacuum relief valve (FIGURE 15). Occasionally, discharge line plugging caused the relief valve to release, necessitating manual unplugging of the discharge line.

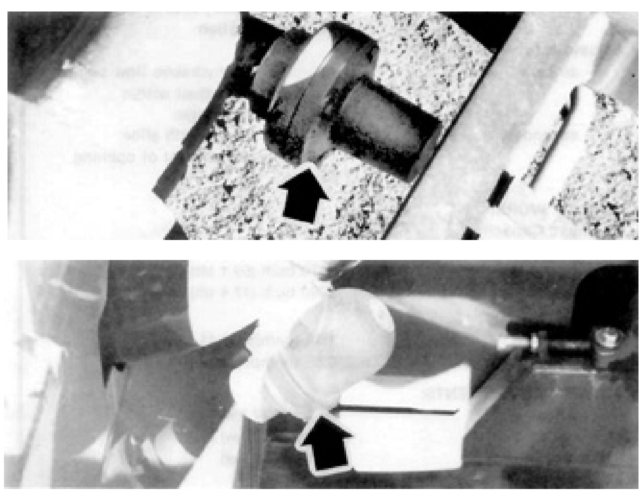


FIGURE 15. Relief Valves: (Upper: Pressure Relief Valve, Lower: Vacuum Relief Valve).

OPERATOR SAFETY

The Conveyair I was safe to operate as all rotating parts were well shielded. The intake nozzle was much safer to operate than a grain auger since there was no exposed flighting or rotating parts. Working near the intake nozzle was virtually dust-free since most dust was conveyed into the inlet. Working near the discharge cyclone was, however, very dusty.

Peak noise levels near the Conveyair I when powered with a 110 hp (82 kw) tractor varied from 96 to 106 dBA when operating on flat open fields. Noise levels when operating near metal bins and enclosed areas became very loud and irritating. The noise level was also very high when working near the discharge cyclone. It is recommended that an operator wear ear protection when working near the Conveyair I.

The Conveyair I was low enough in transport position to pass safely under power lines. Its 7.8 ft (2.4 m) transport width allowed for safe road transport. It has already been mentioned that the operator should take caution when detaching the discharge cyclone for transport, due to the close proximity of the cylinder control to the folding boom.

Although a slow moving vehicle sign was supplied, it was mounted on the rear of the blower shielding and was obstructed from view by the discharge boom. It is recommended that the slow moving vehicle sign be moved so it is not obstructed from view by the discharge boom when in transport position.

OPERATOR'S MANUAL

The operator's manual was clearly written and contained useful information on operation, servicing, adjustments and safety. No parts list was provided. As mentioned before, guidelines for the setting of both secondary air openings should be included in the operator's manual.

MECHANICAL PROBLEMS

TABLE 5 outlines the mechanical history of the Conveyair I during 19 hours of operation. The intent of the test was functional evaluation. The following failures represent those which occurred during functional testing. An extended durability evaluation was not conducted.

TABLE 5. Mechanical History

ITEM	OPERATING HOURS
Positive Displacement Blower	
- the main blower shaft failed and the entire blower was replaced at	1.3
Discharge Boom Seals	
- the seals on the folding discharge boom came off and were reglued using contact cement at	1.9

Positive Displacement Blower: The main blower shaft failed after 1.3 hours of operation. The manufacturer repraced the entire blower and no further failures occurred for the duration of the test.

Discharge Boom Seals: Problems were encountered during the test with the seals on the folding discharge boom (FIGURE 16). The glue, used to hold the seals in place, could not withstand temperatures above 75°F (24°C). It is recommended that the manufacturer provide modifications to prevent seal failure.

FIGURE 16. Seal Failure on Folding Discharge Boom.

APPENDIX I

SPECIFICATIONS

MAKE:	Conveyair I Pneumatic Grain Handling System
MODEL:	Conveyair I
SERIAL NUMBER:	1830158
MANUFACTURER:	Vana Industries Ltd. 92 De Baets Street Winnipeg, Manitoba R2J 3S9

DIMENSIONS:	FIELD POSITION	TRANSPORT POSITION
- overall length	9.1 ft (2.8 m)	9.1 ft (2.8 m)
- overall height	13.7 ft (4.2 m)	7.9 ft (2.4 m)
- overall width	14.0 ft (4.3 m)	7.8 ft (2.4 m)
- wheel tread	7.0 ft (2.1 m)	7.0 ft (2.1 m)

INTAKE & DISCHARGE PIPES:

	TYPE	DIAMETER	LENGTH	WEIGHT
Flexible:	Polyethylene	5 in (125 mm)	14.0 ft (4.2 m)	30 lb (13.6 kg)
	Steel	5in(125mm)	10.0 ft (3.0 m)	401b(18kg)
	Steel	5 in (125 mm)	3.5 ft (1.1 m)	12.6 lb (5.7 kg)
Rigid Pipe:	Steel	5 in (125 mm)	20.0 ft (6.1 m)	80 lb (36.4 kg)
Intake Nozzle	Steel	5in(125mm)	7.3 ft (2.2 m)	29 lb (13 kg)
Clean-up Nozzle	Aluminum	5 in (125 mm)	4.2 ft (1.3 m)	15.5 lb (7.0 kg)

	MAXIMUM	MINIMUM
Discharge Height:	12.0 ft (3.6 m)	12.0 ft (3.6 m)
Reach:	6.2 ft (1.9 m)	

NUMBER OF LUBRICATION POINTS:	9 grease fittings, 10 hour service 2 gear boxes, 100 hour service 2 wheel bearings, annual service
DRIVES:	
- power take-off	1000 rpm
- blower drive	5 V-belts
- air lock	hydraulic motor
DISCHARGE CYCLONE:	
- weight	40 lb (18 kg) with arm
TIRES:	2 implement - 7.60 - 15

WEIGHT:	FIELD POSITION	TRANSPORT POSITION
- right wheel	1037 lb (470 kg)	975 lb (442 kg)
- left wheel	775 lb (352 kg)	820 lb (372 kg)
- hitch	378 lb (171 kg)	395 l b (179 kg)
TOTAL	2190 lb (993 kg)	2190 lb (933 kg)
CENTRE OF GRAVITY:		
- above ground	37 in (916 mm)	33 in (823 mm)
- forward of trailer axle	15 in (383 mm)	16 in (402)
- in from left wheel	43 in (1064 mm)	41 in (1018 mm)

OPTIONAL EQUIPMENT: 14 ft. (4.2 m) length of 4 in (100 mm) diameter polyethylene hose c/w aluminum clean-out nozzle - supplied with test machine.

APPENDIX II

MACHINE RATINGS

The following rating scale is used in PAMI Evaluation Reports:

- Excellent
- Very Good
- Good
- Fair
- Poor
- Unsatisfactory

APPENDIX III

CONVERSION TABLE

1 meter (m)	= 3.3 feet (ft)
1 miilimetre (mm)	= 0.04 inches (in)
1 tonne (t) = 1000 kilograms (kg)	= 2204.6 pounds (lb)
1 tonne per hour (t/h)	= 36.74 bushel per hour (bu/h) for 60 lb/bu wheat
	= 45.93 bushel per hour (bu/h) for 48 lb/bu barley
	= 68.84 bushel per hour (bu/h) for 34 l b/bu oats
	= 44.09 bushel per hour (bu/h) for 50 lb/bu canola
1 kilowatt (kW)	= 1.34 horsepower (hp)
1 tonne per kilowatt hour (t/kWh)	= 27.42 bushel per horsepower hour (bu/hph) for 60 lb/bu wheat
	= 34.28 bushel per horsepower hour (bu/hph) fpr 48 lb/bu barley
	= 48.38 bushel per horsepower hour (bu/hph) for 34 lb/bu oats
	= 32.90 bushel per horsepower hour (bu/hph) for 50 lb/bu canola
1 kilometre/hour (km/h)	= 0.6 miles/hour (mph)

SUMMARY CHART
CONVEYAIR I PNEUMATIC GRAIN HANDLING SYSTEM

RETAIL PRICE:	$14,740.00 (June, 1985, f.o.b. Lethbridge)
EASE OF OPERATION AND ADJUSTMENT:	
Intake Nozzles	Very good, effective for bin clean-out
Filtering System	Effective for filtering wheat, but not grain dust or canola. Easily removed for cleaning.
Transporting	Very good, easily placed in transport position
Adjustments	
- air lock	Adjusted with hydraulic flow control valve. Hard to adjust within recommended range.
- secondary air setting	Easily adjustable with slide. Guidelines for amount of opening required.
RATE OF WORK:	
Maximum Capacity	
- wheat	2590 bu/h (70.4 t/h)
- barley	3170 bu/h (69.1 t/h)
- canola	2090 bu/h (47.4 t/h)
Specific Capacity	
- wheat	1.16 ton/hph (1.41 t/kWh)
- canola	0.85 ton/hph (1.03 t/kWh)
POWER REQUIREMENTS:	
- wheat	68 hp (50.7 kW)
- barley	78 hp (58.2 kW)
- canola	61 hp (45.5 kW)
QUALITY OF WORK:	
- grain damage	Similar to a grain auger in cereal grains. High in dry canota.
OPERATOR SAFETY:	Dust free. Ear protection required.
OPERATOR'S MANUAL:	Contained useful information. No parts list provided.

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