Residues to Revenues 2009

Innovations in Residues Processing Technology

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Forest residue recovery, in the southern hemisphere, differs from that of the northern hemisphere, principally due to the faster growing nature of the trees, and our extraction methods.

The use of skid sites and haulers preclude the conventional approach to gathering. While there has been an increased use of mechanization, many hurdles are faced by logging contractors, besides the terrain. These are: the underfoot conditions, variety of cuts, the log size and the increased inaccuracy of mechanised harvesting heads, due to the size of the wood. These preclude the use of cut-to-length at the stump and forwarder operations used else where in the world.

The majority of wood is extracted using haulers or log skidders. As the logs are dragged along the ground, they contain much more dirt as a consequence. In the winter, skid sites may be up to 500mm deep in mud. Off cuts and residue rapidly become buried in this, or bull dozed to the side, out of the way.

As there is no monetary reward for contractors to treat residue, as any thing other than “waste”, there is no priority, at all, given to the care of it. On super skids throughout New Zealand, hundreds of thousands of tons of wood waste has been pushed into gullies, buried or generally treated without any regard for recovery.

The residue available at skid sites varies in size, from slash to large butt ends and double leaders. The large sized product damages conventional hoggers, so it is either left behind or transported to a central position, for processing by a tub grinder. Tub grinders are notorious for noise, projectiles and very high running costs.

Tramp steel and rocks are always present in residue. The premature and catastrophic failures this causes, in conventional hoggers, makes operators wary of processing away from a known site.

The volumes available at normal skid sites mean that often, less than a days hogging is available. The wastage from processing directly onto the ground, with the average loss of 12% is a serious issue. Short set up time is also a crucial factor.

To address these issues, it was decided a fresh approach was needed. The following criteria were set:

- Easily transportable around fragmented forests, without the need for expensive transporters
- Must be safe to be around, with no dangerous projectiles
- Must operate with low noise and dust levels
- Able to process all skid site waste, without pre-sorting or prepping
- Able to produce clean boiler fuel, from dirt-contaminated waste
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- Must address the issues of wear and catastrophic failure
- Must be fuel efficient.

By studying current hogging technology, it was decided to group the multitude of machines into 3 broad categories:

**Horizontal drum rotor type**

These consist of an in-feed system, a drum-type rotor, with flails or teeth and an out-feed system, by far the most common type. The draw backs with this type are:
- All product must pass through the rotor, consuming unnecessary horse power
- The screening area is the grate around the rotor, which, as it wears, alters the product size
- The screen area is high speed. High speed = high wear
- Known to be extremely expensive, when damaged by tramp steel etc

**Tub grinders**

These utilise a drum-type rotor, as above, with a rotating tub above the rotor, as the in-feed. Their draw backs are:
- All of the faults above, plus:
- Projectiles can be generated
- The process “grinds”, more than cuts, using much more fuel
- Have high in feed heights.
- Can be very noisy
- Generally require engines of 600HP or more

**Universal Refiner types (and their clones)**

These use a rotating disc, in the bottom of a tub. There are several variations: some the tub turns, and others, the rotor orbits about the centre of the tub. Their draw backs are:
- Complex drive systems, as the drive must turn 90 degrees to the engine, causes high parasitic losses and consequent high fuel consumption.
- Very high wear on the rotor, as it is always in the material
- Prone to projectiles, so must be covered
- Intermittent feed system often employed, makes them extremely high to load.

Progressive Equipment staff had exposure to repairing and modifying a variety of hoggers, from tub grinders and horizontal drum-types, to the Universal Refiner type clones. All machines capable of processing the large sized material, had shortcomings with dirt, wear, noise, safety, transportation or running costs.
We evaluated all types and noted their best points, and then, we set to work, to design a machine to address the issues we had.

**DESIGN CONSTRAINTS**

We noted that the screening area played an important part in the quality of finished product and that low speed screens retained their consistency longer. We also noted, that the Universal Refiner types, with moving grates, tended to separate product before processing, increasing production and reducing fuel usage. We saw that Trommel screens, (large rotating cylindrical drum screens) were used extensively to post-screen. They give the largest screen area, for their size. So, we made a heavy duty one. The drum contains 2.5 tons of material, on average. This can be sifted and screened, up to 75 times, during the reduction process. By increasing the screen area by a factor of 10, the grate apertures can be made closer to the desired product size.

We identified that a vertical plane rotor chipper, although not used in hogging, was the most efficient, as the rotor was only contacting the product in one place. The rest of the rotor was in free air. We integrated this concept, into the inside of our Trommel Screen.

We could see no reason, for the disc to be parallel to any particular face, in a circular drum. This allowed us to place the rotor in a vertical plane, making the drive system a very simple and basic set of V-Belts.

It then became obvious, that the disc could be positioned at an angle to the drum, causing the processed product to be flung away from the rotor, where it had to pass through the screening process, before it could return to the rotor. This is the first internal “Closed Loop” screening/hogging process known. As it uses the previously wasted energy, imparted onto the processed product, it shifts the product inside the drum, without the need for any extra energy input.

By placing the rotor at an angle, and counter rotating in relation to the drum direction, the damage caused through tramp steel is reduced, as the rotor tends to repel the hard product away from itself. The steel does a corkscrew around the drum, landing back in the product, where it takes time to return to the rotor. This gives the operator time to respond.

The angled rotor also creates a tearing action, on the product, which requires less energy than a cutting action. It also creates less wear. This enabled us to utilise a very large rotor diameter of 2m. We were able to increase the number of teeth up to 54. This increases tip life as, they are all share the work load.
Many Trommel screens make a split-sized product. We reasoned, that we could utilise this technique, to separate the dirt and fines, with some modification. By fitting “dirt weirs” inside the upper portion of the drum, the movement of dirt down the drum is slowed, increasing the efficiency, without affecting production. The dirt is crushed to a fine grit, by the tumbling logs etc, reducing it to a consistency of potting mix. By removing the dirt, the wear inside the hogger is greatly reduced. 90% of the dirt is removed, in the first 2m of the drum.

We have also perfected the introduction of waste exhaust heat into the drum to assist in reducing the moisture content of the product. This is achieved in conjunction with a curved panel that sits closely on the outside of the drum that prevents over length product from exiting. The product is carried back around to be reprocessed.

Many split, folding out-feed belt systems, have issues with alignment. By making the out-feed belt one piece and folding it over the top when transporting, these problems were removed. This gave us a high out-feed height, with minimal set-up time. Chip liners can be filled direct, reducing waste, contamination and loading time.

This has worked very satisfactorily, provided that trucking logistics are matched. We have produced 35,000M direct into truck and trailers, with favorable comments from the drivers, who like it, as their equipment is not getting damaged by small wheel loaders, trying to reach over the high sides, on uneven ground. The waste, caused by using product for loading ramps, is avoided. An extra 4,800M would have been required to be made, had we processed direct onto the ground.

If stock piling, a high out feed allows machines to enter from the hogger side and sweep the product away to the rear. We have had a D8N clearing for us, when processing on a concrete pad.

Progressive Equipment was approached by Pan Pac, Napier, in 2004, regarding residue recovery, to fuel their recently commissioned Co-Gen plant. Their forest residue, being eastern coastal wood, is by nature large, dense and hard to process. They had studied various hoggers and were interested to try.

The initial trial of 5000 tons was of forest residue, stored for over 1 year and containing in excess of 50% dirt. The product had been bulldozed into heaps. The site was too wet to operate with wheel loaders. This was a testing environment to produce clean boiler fuel.

Other hogging contractors, who had viewed the site, had priced to prep the site, by pre-sifting and sorting with an excavator, with no guarantee of clean product at the end. This is a time-consuming and expensive operation that relies on the skill of the excavator operator, for a successful outcome.
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The WoodWeta, with its internal screening system, was able to separate out the wet and contaminated product in one pass, removing the need for post screening. All sized products were processed at once, no splitting or prepping required. Some of the finished product was loaded directly into trucks, minimizing contamination; the remainder placed in 150M3 piles for collection.

The finished product averaged between 2% and 9% dirt, an average reduction of 45%.

The prototype machine was sold to Terry Robinson and Ian McLaughlin in 2006, and has been based in Kawerau / BOP since. It has since processed over 120,000 tons of a wide variety of product, including oversize hardwood and softwood logs, plywood, LVL, packets of loose veneer, stumps, paper, MDF, and yard sweepings. It is now the only on site hogger supplying the Norse Skog Pulp Mill.

During this time it has had several severe steel strikes, ranging from track rollers off 20 ton excavators to 40mm steel plates. Apart from broken teeth, which are designed to shear off on high impact, there has been no catastrophic failure of any components.

The original mild steel grates are still intact inside the drum after 5000 hours of operation. We believe they will last another 3000 hours before replacement is required. The rotor has been hard faced once on the outer surface, the inner surfaces have never been touched.

The second production machine is built and is sold to an Australian operator for use in processing C and D waste.

Since the development of this unit we have designed and are in the process of building a purpose built green waste / participle waste machine, using the knowledge gained from our field trials.

The current regime of weight based payment for hog fuel precludes any incentive to produce a clean, dry product. A5% dirt content adds 20% of value by weight, so why would any contractor choose to penalize themselves by spending time and resources to ensure pristine product. While the forest residue recovery is in its infancy, contractors can pick the eyes out of the product, removing only the clean, easily accessed solid wood on top. Once this cream has gone, recovery costs, due to post screening, will drastically increase.

Quality product will be the driver for the change to calorific based purchasing. The full potential for this type of machine will be realized when this change is made.