Used Horse Bedding & Broiler Litter Gasification Feasibility Study

Introduction

Horses and broiler production are a large part of B.C.'s agricultural sector, providing substantial economic benefit and employment to B.C.'s economy. Both horses and broilers require bedding. Disposal of used broiler litter and horse bedding, consisting of wood shavings, manure, urine, and uneaten feed, can be a challenge for both broiler farms and equine facilities in the Lower Mainland.

Used horse bedding contains little nitrogen and is therefore not an effective fertilizer. While composting used horse bedding reduces mass and increases nutrient concentration, thereby improving desirability, composting is challenging for many equine facilities in the Lower Mainland with limited space, infrastructure, and resources. Used broiler litter is a desirable fertilizer. However, currently there are more nutrients available in the Lower Mainland than are needed for the crops that are grown or that the land can sustain. This nutrient surplus can make it challenging to find land in the Lower Mainland on which to sustainably apply broiler litter.

Due to limited space for composting and the nutrient surplus in the Lower Mainland, some broiler farms and many equine facilities are looking for more sustainable, local, long-term, year-round alternatives to local land application of used horse bedding and broiler litter.

Gasification

Gasification involves the partial, oxygen starved combustion of feedstocks, such as used broiler litter and horse bedding, at temperatures of 800 – 1,400^{o}C to convert the feedstock's chemical energy into a combustible gas called syngas. Syngas can be utilised to produce renewable heat, or renewable heat and electricity. The by-product of gasification is ash. This ash can have value for use in fertilizers.

A gasification plant in the Lower Mainland would provide broiler farms and equine facilities with a sustainable, local, long-term, year-round alternative to the land application of used horse bedding and broiler litter. However, while used to produce energy from coal and wood, the technical and economic feasibility of building a gasification plant in the Lower Mainland to convert used broiler litter and horse bedding into renewable energy and ash is currently unknown. Determining the technical and economic feasibility was the reason for this study.

Gasification Test Results

To determine the technical feasibility of gasifying used horse bedding and broiler litter, gasification tests were carried out by the SP Technical Research Institute of Sweden using six different mixtures of broiler litter and horse bedding collected from farms in the Lower Mainland (Table 1). The gasification tests were used to determine:

- Syngas production and quality;
- Optimal feedstock mixtures;
- Potential feedstock issues; and
- Ash volume and quality.

Table 1: Different Mixtures of Used Horse Bedding and Broiler Litter (% by mass)

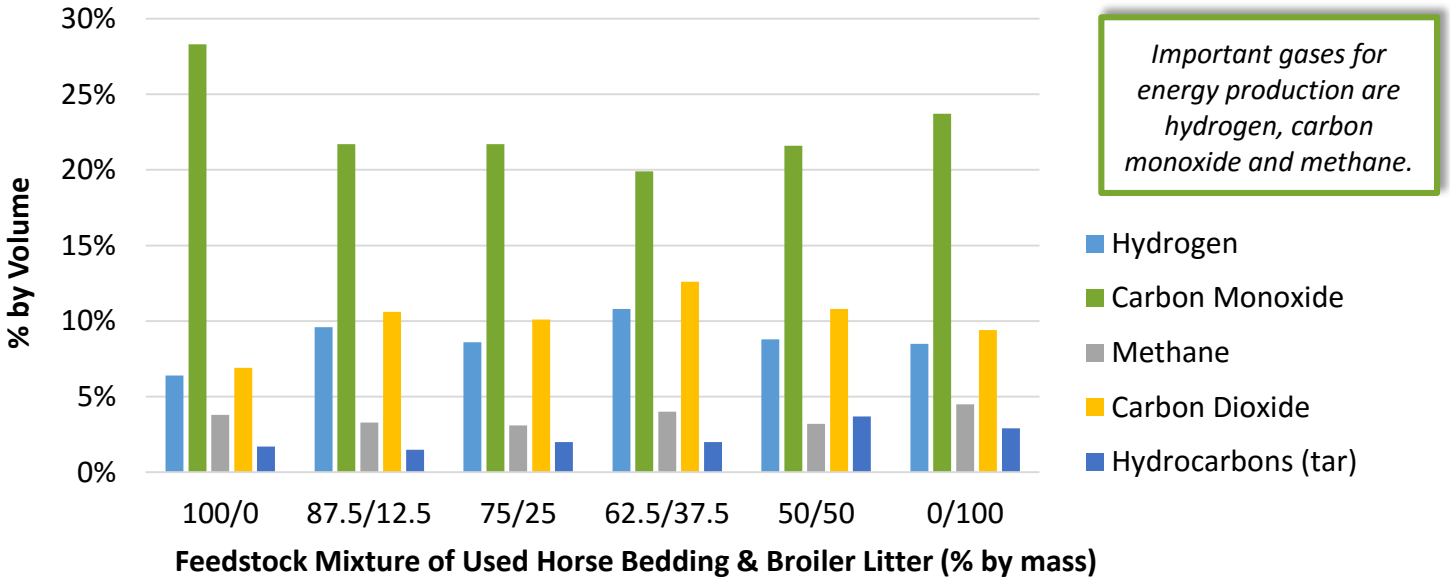
Used Horse Bedding	Used Broiler Litter
100	0
87.5	12.5
75	25
62.5	37.5
50	50
0	100

Syngas

All six feedstock mixtures gasified produced high quality syngas similar to that produced from the gasification of wood (Figure 1). This means that used broiler litter and horse bedding are suitable feedstocks for gasification. The gasification tests also showed that different feedstock mixtures of used horse bedding and broiler litter had little impact on syngas production or quality. This means that the choice of feedstock mixture should be based on the cost and difficulty of feedstock acquisition.

The only issue encountered during the gasification tests was with 100% used horse bedding, which resulted in significant ash sintering at a temperature of 860°C. This means that if high temperatures are used for gasification (>800°C), at least 12.5% broiler litter should be mixed with used horse bedding to avoid ash sintering.

Figure 1: Test Gasification Syngas Results*



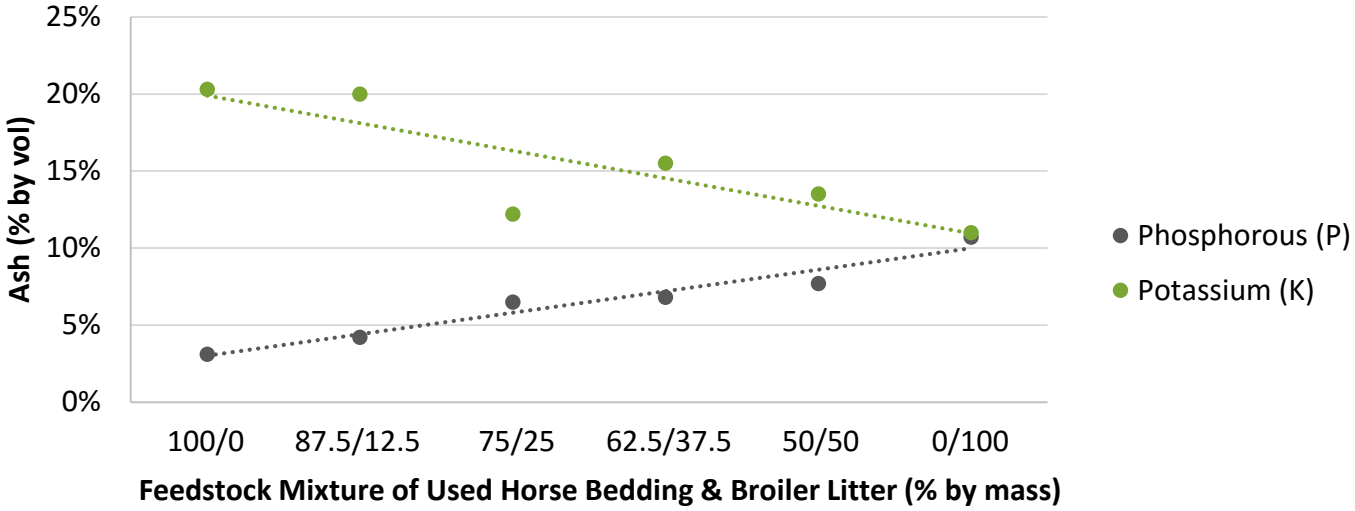
** Any variations in syngas compositions between the six feedstock mixtures was caused by variations in gasification temperatures and feeding rates, and were not due to the different feedstock mixtures of used broiler litter and horse bedding.*

Ash

The volume of ash produced from the gasification tests ranged from 5.2 – 7.9% by mass. These volumes, which were lower than expected, showed no pattern between volume of ash and feedstock mixture gasified. The phosphorous and potassium contents of the ash were high, and showed a clear

increased/decreased based on feedstock mixture (Figure 2). This suggests that the ash could have economic value as a fertilizer input, regardless of feedstock mixture.

Figure 2: Ash Phosphorous & Potassium Content



Technology Selection

EQTECs fluidised bed gasification technology was identified as the most appropriate gasification technology for used broiler litter and horse bedding. This choice was based on the technology's high tolerance for feedstock heterogeneity, and the technology's scalability and low operating temperatures (thereby avoiding potential ash sintering). Production of renewable heat and electricity was chosen as the most appropriate energy generation pathway. This choice was made because large amounts of heat will be required to dry the feedstock prior to gasification, and injecting renewable electricity onto the B.C. Hydro grid year-round is much easier than selling heat year-round.

It is proposed that the EQTEC gasification plant should gasify 37,500 tonnes/year of used bedding and 12,500 tonnes/year of used litter to produce 10MW of clean syngas. The syngas would be combusted in combined heat and power engines to produce renewable electricity and heat. The renewable electricity (3.95MW) would be sold to B.C. Hydro under the Standing Offer Program, while most of the heat would be used to dry the used horse bedding and broiler litter to 12% moisture content before gasification. Any remaining heat (1.85MW) would be sold locally.

Site Selection

If the EQTEC gasification plant were built in the Lower Mainland, it should be built within close proximity to the feedstock (used broiler litter and horse bedding), be able to connect to the B.C. Hydro grid with minimal difficulties, and be located near to sufficient heat demand to enable the sale of any remaining heat. With these necessary characteristics in mind, two potential areas in the Lower Mainland were identified for the gasification plant. The first is on the boarder of Langley and Surrey near the Golden Ears Bridge, the second is on the boarder of Langley and Abbotsford near Highway 1. Further research into both of these areas is required to determine exactly where the gasification plant could be located.

Economic Feasibility

The economic feasibility of building a 50,000 tonne/year EQTEC gasification plant in the Lower Mainland was assessed (Table 2). This assessment showed that based on cash flow projections for the initial 10-year operating period, and assuming net annual revenues from the sale of electricity, heat, ash, and a $10/tonne horse bedding tipping fee, and 8% interest and 2% inflation, 40% funding is required to generate an attractive Internal Rate of Return (IRR).

Table 2: Economic Feasibility of a Gasification Plant in the Lower Mainland

Item	Amount
Total capital investment	$29,315,000
Total annual operating cost	$1,733,000
Total net annual revenues	$4,462,080
Gross annual operating profit	$2,729,080
Funding (40%)*	$11,700,000
Internal Rate of Return (IRR)	**16.1%**

* 40% funding deemed reasonable for a project with such wide-reaching agricultural and environmental benefits.

Sensitivity Analysis

Of the estimated values for capital costs, funding, tipping fees, ash sales, and financing, the most critical to economic feasibility are capital costs and tipping fees. For example, a 5% increase in capital costs reduces IRR to 10.5%, while a 5% decrease increase IRR to 25%. An increase in tipping fee for used horse bedding from $10 to $20/tonne or $30/tonne decreases required funding by ~$2 million (17%) and ~$4 million (35%), respectively.

Disclaimer

Acknowledgments

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