2015 Design Goals and Initial Findings

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Abstract

In their first year of competition, the University of Minnesota Clean Snowmobile Team looked to identify areas of their snowmobile that need improvement and develop engineered solutions. The areas primarily identified by the team include minimizing weight gain from added components, identifying promising ways to reduce emissions and noise pollution, as well as other simple modifications that would balance performance and efficiency.

Goals

- Improve efficiency
- Reduce overall noise
- Maintain an exciting trail riding experience
- Create a economical, efficient solution to noise and pollution.

Findings

Improve efficiency

As the purpose of this competition is to modify a stock snowmobile in order to increase fuel economy and reduce emissions, the choice of an engine is critical. This year, the goal of the team was to meet the requirements for competition with the simplest solution possible, and to build a foundation for future teams.

Through the team's sponsorship from Polaris, a 2015 Indy 600 SP snowmobile was selected by the team because of its low cost, high power to weight ratio, and handling characteristics, specifically on groomed trails. An Indy comes equipped with a Liberty 599cc, two-stroke, semi-direct injection engine. Because of this engine's simplicity, low weight, high power, and the preference of using the stock engine, the Liberty was selected.

Because isobutanol has a lower energy density than gasoline, converting the engine to run on an isobutanol blend requires that more fuel must be injected. New engine management systems were explored to accomplish this and to also accept additional sensors such as an alcohol content sensor.

Piggyback systems that interfaced with the stock ECU were also considered, but a fully custom solution was selected because of the ability to reuse the ECU and software package regardless of the type of engine used in the future. A performance electronics PE3 unit was selected based on its low price, free software package, and the ability to add additional sensors.

Reduced overall noise

Constrained linear damping is a noise reduction method that makes use of the relative stiffness between two materials in order to dissipate sound energy. A material with relatively low stiffness is adhered directly to a surface within the system. Then another material with a relatively high stiffness is adhered on top of the low stiffness material. The resulting laminate dissipates noise by distributing the energy of sound waves throughout the lower relative stiffness material.

Implementation of this method of noise damping will be targeted on inside of the tunnel. The flat surface will allow sheets of material to be easily be adhered to it.

Two materials for the elastic portion of the laminate were considered, foam and rubber. There was concern that the foam may compress over time, and as a consequence lose some of its elastic nature. It is believed that rubber will not experience such problems. It is proposed that medium strength neoprene rubber be used for the elastic material in the laminate.

Three rigid materials were explored: plastic, aluminum, and structural fiberglass. The plastic option was ruled out due to its relatively low melting point and close proximity to the cooling system. Aluminum was priced and found to be very expensive, so it was ruled out as well. It is currently proposed that structural fiberglass be used for the stiff material due to its relatively high heat tolerance and low cost.

The team would have tested constrained linear damping, but time constraints prevented the team from entering the testing phase of the design process. As a result, constrained linear damping will be tested and implemented next year.

Belt drive

A stock 2015 Polaris Indy 600 snowmobile is equipped with a chain that connects the jackshaft to the drive shaft. Although it has not been tested, it can be assumed that the chain creates a significant amount of noise as it spins at high speeds. The final drive chain and the gears on which the chain travels are also made of steel. This material selection leads to a significant addition in the amount of rotating mass that the engine must overcome to accelerate the snowmobile.

Mechanical noise can be improved upon by converting the chain drive to a belt drive. The belt drive will not create as much noise because the belt will not have the same rattle as the chain drive metal to metal contact. The belt, along with the aluminum gears that we plan to implement, will reduce the amount of rotating mass in the snowmobile. In doing so, the engine will not have to work as hard to drive the snowmobile. This will result in the snowmobile having a better fuel economy.

Examples of belt drive systems are the C3 SyncroDrive and CMXDS belt drive kits. Both of these systems claim to give better throttle response with faster acceleration and a higher top speed compared to a snowmobile with a chain drive. For these reasons we believe that it would be beneficial to convert our snowmobile from a chain drive to a belt drive in the future, with appropriate testing.

Exciting Trail Riding Experience

The skis chosen for the sled were model TRX from C&A Pro Skis. These were chosen in order to improve fuel economy while not sacrificing handling or performance. The skis are 6” wide at the front and taper to 3.5” at the rear. This design allows the snowmobile to float on powder while reducing unneeded surface area and drag, increasing the fuel economy. The keel runs the full length of the ski, unlike the stock ski, which helps turning in powder and loose snow. Increases in fuel economy with no reduction in handling and performance are ultimately why these skis were chosen.

The runners—or carbides—chosen to pair with the skis were Woody's Trail Blazer IV TCA-5000, which have a 6" runner with 60-degree pitch. These carbides fit with the new skis and were also chosen to increase fuel economy while sacrificing neither performance nor handling. A 6" runner was chosen to accompany a studded 121" track for multiple reasons. With too short of a runner, the snowmobile will under steer because it has too much grip in the rear end. In contrast, a longer runner may cause the snowmobile to over steer and dart as it cuts into existing ski tracks. A 60-degree pitch is the standard pitch for consumer carbides, compared to a 90-degree pitch, which is used predominantly for racing. The 90-degree pitch provides better grip but wears out quicker, making the 60-degree more economical. These criteria contributed to why these carbides were chosen—to increase fuel economy without sacrificing performance and handling.

The snowmobile track that was chosen was the Ice Attak XT 9200H from Camoplast. This 121" track fits well with the snowmobile design goal. It is a pre-studded track for additional grip on hard surfaces—like packed snow and ice—that are common on groomed trails. The studs are molded into the lugs of the track, which decreases the weight from nuts and backings from other aftermarket studs. A studded track increases grip on the trail, which increases acceleration, decreases fishtailing under heavy braking, and decreases sliding in corners. The studs on the track also increase both safety and rider satisfaction while keeping weight addition to a minimum. The lugs on the Ice Attak XT are 1.22" long and are designed for trail riding. This added traction will provide better performance than the stock track's 1" lugs. Longer lugs allow for better grip in loose snow, which is present on trails that are not groomed, ditches, and lakes. The rubber on the track increases lug rigidity, which increases traction on packed trails as well.

MSRP

A stock 2015 Indy 600 SP is available from Polaris for $8999. Current proposed additions to the sled include a new engine tune, skis, carbides, track, belt drive, and noise reduction material. After implementing all these additions, our suggested retail price would be $11984.88

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