

INTEGRATED TECHNOLOGY AND MULTIMODULE TRACKED VEHICLES UNIT FOR WETLANDS PROTECTION

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Abstract

Integrated technology and new generation of multimodule tracked vehicles unit was designed by PIMR- Industrial Institute of Agricultural Engineering in Poznan within the research project WND-POIG.01.03.01-00-164/09. The Tracked Vehicles Unit (TVU) was built as a part of cooperation with Polish firm Hydromega. TVU is dedicated to work on wetlands and should have positive impact on ecology and better environment protection thanks to use of biodegradable oils and lubricants, diesel engine with Stage III emission standard, innovative tracks which have different internal and external speeds during turns. A single-phase technology is designed for harvesting/collecting and transporting biomass (reeds, grass, bushes, small trees) on wetlands, especially these that are located in National Parks and Nature 2000 areas. The TVU is designed to work with different tool modules for cutting, shredding and transporting collected biomass on wetlands. Amphibian type of the TVU's hulls allows for work in inland water (rivers, lakes, canals).

Keywords: VEHICLE, TRACKED, UNIT, BIOMASS, MOWING, TRANSPORT, WETLAND, ENVIROMENT, PROTECTION

1. Introduction

PIMR - Industrial Institute of Agricultural Engineering in Poznan, Poland realizes R&D project No. WND-POIG.01.03.01-00-164/09 on implementation of the technologies for works related to stopping unwanted (grass, reeds, bushes) greenery succession on wetlands and restoring the breeding areas of endangered species of birds [1].

Existing technology in Poland

The farmers had outdated and worn out vehicles and machines, which are potentially and very often the real cause of decreasing the environment's protection – mainly, because crawler-type vehicles – snow grooming ratracs - are poorly adapted by farmers or operators for harvesting biomass in summer months. Overheating of the ratrac's engine with protecting cover lifted (Fig. 1) is very dangerous; a few times the biomass dust and residues of oil and grease ignited a fire resulting in destruction of the engine and oil spillage from broken hydraulic hoses. To our knowledge, the ratracs had mineral oil rather than biodegradable oil, the spills have not been recovered and remediation actions have not been taken. One cc of mineral oil can spoil up to 5000 cc of clean water and it will be in ground or water for years [2].

Devastation of peat's top layer that was made by sharp edges of grousers of the tracks in the field is very dangerous for vegetation and environment, especially on wetlands located in National Parks in Poland and Europe as well (Fig. 2) .



Fig. 1. Rattrack adapted by farmer to work on wetlands, blue color cover is open - for better cooling of the engine¹ □



Fig. 2. Top peat layer devastation made by steel tracks of snow grooming vehicles¹

2. Virtual models of tracked vehicles unit

The virtual models of Tracked Vehicle Unit (TVU) prototype with track modules that are powered by 6 hydraulic engines and independently steered was designed in PIMR. The TVU is designed

to work with different tool modules for cutting, shredding and transporting collected biomass on wetlands (Fig. 3-5)

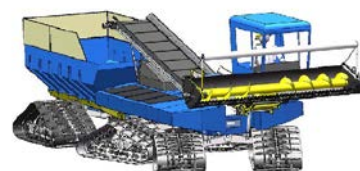


Fig. 3. Virtual model of the Tracked Vehicle Unit for cutting grass, reeds¹



Fig. 4. Virtual model of the Tracked Vehicle Unit for cutting reed, underwater plants on lakes and channels¹



Fig. 5. Virtual model of the Tracked Vehicle Unit for moving, collecting and transporting biomass (grass and reeds)¹

During turns the delta shape tracks (fig. 6) in tractor unit have ability to lean out in different direction (fig. 7). In addition, developed by small medium size firm Hydromega [4], hydraulic tracks' steering system will control speed during making such turns and/or turning.

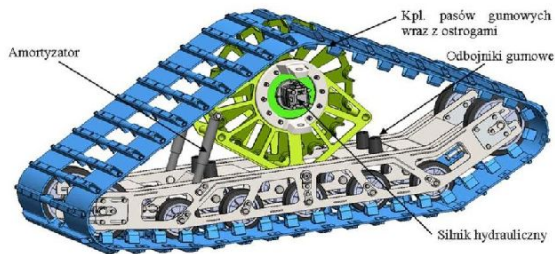


Fig. 6. Delta shape track implemented in TVU [3]

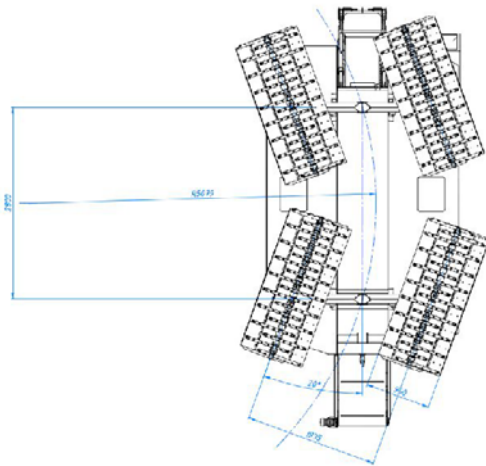


Fig. 7. Delta tracks' steering system should allow to lean out in different direction the front pair and rear pair of the tracks [3]

3. Prototype of tracked vehicles unit

In 2013 year the PIMR-BE Research Group designed prototype of the TVU that is dedicated for harvesting and collecting the biomass and transporting it to temporary storages. The prototype unit was built together with Hydromega [4].

The main purpose is that innovative tracked vehicle unit should be able to move on boggy, muddy terrains and, in addition, that can work on lakes, small rivers, and channels. Caterpillar vehicles, like snow groomers (ratracs) and tracked tractors, can drive on boggy terrains, harvest and transport biomass, but when there is a few centimeters of water on the surface of the ground, they can get stuck, if one of tracks will sink into a hidden meliorative ditch or hollow.

An amphibian type unit can minimize threats - survive in such situations and continue harvesting work on wetlands.



Fig. 8. TVU ready to preliminary field test , on the top of mast is mounted Racelogic's HD video camera. Presented version of tractor and trailer is an amphibian unit that should be able to move through water (lakes, channels) (October 2013)¹



Fig. 9. TVU removes small tree (October 2013)¹



Fig. 10. TVU mowing grass during preliminary field tests (October 2013)¹



Fig. 11. Effects of mowing grass. Trails without damages of the top ground layer (October 2013)¹



Fig. 12. Effects of TVY's cutting and collecting biomass on wetland - no visible damages of top layer of peat¹

The Racelogic's systems [5] (Video Vbox equipped with two HD video cameras and Vbox3i) were used to collect data during fieldwork and video equipment for recording images from cameras placed: in the cabin, on the top of the telescopic mast (fig. 8) and on the Unmanned Aerial Vehicle (UAV), that was rebuilt as KoBE in PIMR and adapted to take-off and land on fields or lakes [6].



Fig. 13. KoBE during take-off on the Bablino lake¹



Fig. 14. No visible ground deformation during TVU turning (picture made by video camera mounted on KoBE)¹



Fig. 15. TVU's tractor during preliminary lakes tests (picture made by KoBE's video camera)¹



Fig. 16. TVU during winter tests (February 2014)¹

3. PIMR's integrated technology for removing biomass on protected wetlands

Developed by PIMR integrated technology for removing unwanted greenery from protected wetlands includes following operations:

1. mowing grass and reeds ,
2. cutting reeds and underwater plants,
3. removing small trees and bushes
4. collecting biomass
5. transporting biomass to temporary storages and/or special prepared places in the field
6. Transporting biomass to the warehouses located outside protected areas

Operations 1-5 need to be checked in different locations and weather condition during 2014-2015 years. Operation no. 6 is alternative technology of transporting biomass to the warehouses located outside protected wetlands that was invented by PIMR and it already got several Polish and European patents [7, 8]. This biomass train technology is practically ready for market implementation, especially on mires and peat land of the protected wetlands.

New innovative technology is based on special steel adapters that are used to form biomass train and transport it, by rolling bales on the ground, behind towing vehicles e.g. agricultural tractor with wheels (fig. 17) or tracks, the tracked tractor of TVU (fig 18) or medium size trucks and pickups equipped with delta track modules or 4x4 wheels (fig. 19).



Fig 17. Biomass train towed near Notec River, Byszowice village [9]

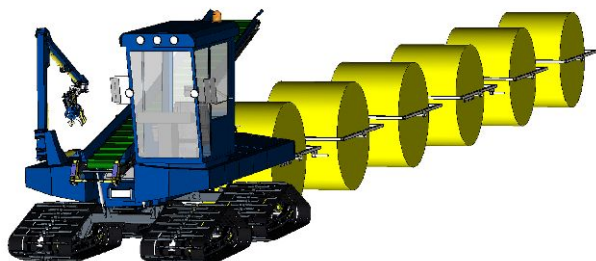


Fig. 18. TVU's biomass train - tractor towing bales¹[10, 11]



Fig. 19. Mitsubishi L200 research truck with bale (dia. 1,8 m) [9]

PIMR bought Kubota M9960 agricultural tractor in which wheels were replaced by Soucy Track's delta type modules. Tracked Kubota tractor will be used in research field tests to tow biomass bales (fig. 20).



Fig. 20. Kubota M9960 tractor with delta tracks module made by Soucy Track, Canada¹ [12]

4. Conclusions

1. The preliminary results indicate a good drive ability of new tracks units, practically, with no negative impact on the ground as in the case of machines built on the snow grooming vehicle's (ratrack) chassis.
2. Diameter of turn using only front pair of tracks is around 34m, but when two pairs are actively helping to turn - it is around 9-10m.
3. The Tracked Vehicle Unit ran easily on the grass, as well as on peat land or snow.
4. More advanced field tests of mowing, cutting, shredding and transporting biomass as well as of the TVU's impact on peat land will be run during 2014 and 2015 years.
5. Developed and patented by PIMR technology of special adapters and methods of forming biomass train is practically ready for demonstrator type projects and for market implementation.

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