

The Portable Filtration System FA 2-3 were used for cleaning. This system was modified with filter element SDFC 1888 (Super Duty Filter Cartridge). The element can absorb water (max. 0,56 litre) and it removes of particle ( $> 3 \mu\text{m}$ ,  $\beta_3=100$ ) from hydraulic oil HM32.

Experimental results of off-line filtration are shown in Figure 6.

### Conclusion

Controlling water is like controlling cholesterol: it is not something you can attempt occasionally and expect good results. It requires a change in lifestyle, which may require some major procedural revisions and some minor machine

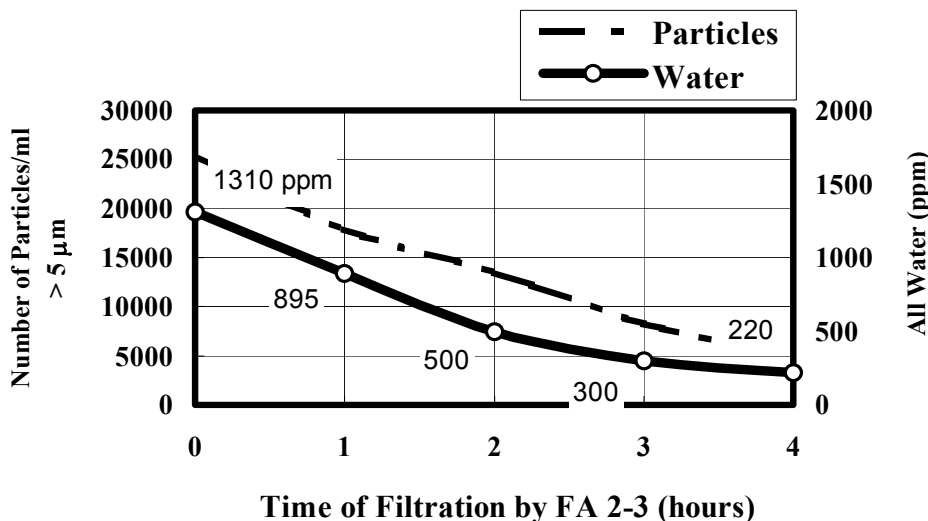


**Figure 6. Oil servicing and cleaning of hydraulic system KN-251**

modifications. However, given the damage water can cause, the change is well worth the effort. The Proactive maintenance is presented as an important means to cure failure root causes and extend machine life. We have to realise it periodically. The water contaminant monitoring and cleaning provides "the first defence" against corrosion, degradation of oil and mechanical failure.

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### EVALUATION OF TIMBER EXTRACTION MACHINES IN TURKEY

In forestry, like every kind of production, production works require a productive power. This productive power can be provided by both human power or animal and machines

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which are used by human beings. The production of wood raw material are formed various stages that continues from the productive place to market center. These work stages depend on each other like rings of a chain. Success and failures in each stage effect the next stage.

However the increasing of forest product that is formed in our country recently, now hauling has been still made with old patterns, such as sliding, throwing, circling, transport with human, skidding with animals on direct ground. Besides special forest tractors and skylines are used in some areas. In this study researched technical features and work performances of MB Trac tractors and skylines in our country.

**Keywords:** Tractor, Skyline, Timber, Extraction, Turkey

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## Оцінка лісотransпортних машин, які використовуються в Туреччині

Для виконання виробничих завдань у лісовому господарстві, як і в інших галузях економіки, застосовується робоча енергія тварин, людей чи машин. Процес лісозаготівельної діяльності можна представити, як сукупність декількох стадій, подібно до ланок одного ланцюга, де успіх і невдачі на одній ділянці впливають на кінцевий результат.

Незважаючи на зростання обсягів лісозаготівельного виробництва, первинне транспортування деревини в нашій країні проводиться за старими схемами: ризування, скочування, трелювання тваринами до лісової дороги. Крім цього, у деяких регіонах використовуються спеціальні лісопромислові трактори та ливове обладнання. Досліджено технічні можливості та продуктивність тракторів MB Трас та ливового обладнання, які використовуються для трелювання деревини в Туреччині.

**Ключові слова:** трактор, ливове обладнання, деревина, трелювання, Туреччина.

### 1. Introduction

The production of wood raw material are formed various stages that continues from the productive place to market center. These work stages depend on each other like rings of a chain. Success and failures in each stage effect the next stage.

The transport of forestry products is realized in two stages. The first one is the primary transport stage which involves the haulage of timbers, while the second one is the secondary transport stage involving the main stage of transport of timbers, generally realized by trucks on forest roads [1].

However the increasing of forest product that is formed in our country recently, now hauling has been still made with old patterns, such as sliding, throwing, circling, transport with human, skidding with animals on direct ground. Besides special forest tractors and skylines are used in some areas. The level of harvesting mechanization in developed countries is higher than Turkey. While mechanical harvesting is about percent 86 in Austria that is similar to Turkey, this ratio is about percent 9 in Turkey [2].

Protuctive forest are generally, found in mountainous areas which have %40-80 gradient in Turkey. Timbers hauglage studies are usually practised with tractor winches that have double or single drums. Timbers are skidded directly on the surface with tha shape of cable hauling by tractor winches. Another way of timber haulage is to benefit from skylines. Tractors are used in areas winch have % 30-35 slope gradient. But skylines are used in areas that have % 55-75 slope gradient [3].

Koller K300, URUS MIII and Gantner skylines are used in East Blacksea forest areas. Special forest tractors like MB Trac 800 – 900 – 1000 – 1100 and farm tractors. Like steyr 768, Ferguson are used in almost every forest areas in Turkey [4].

## 2. Materials and Methods

Turkey, with 97 % of its land in Asia and 3 % in Europe continents, is located between 42 ° 06' – 35 ° 51' N altitude and 25 ° 40' – 44 ° 48' E longitudes. Turkey is surrounded with the Mediterranean, the Black Sea, the Marmara and the Aegean Sea, has an area of 77 945 200 hectares [5].

**Table 1. Amount of extraction machines used in Turkey (2004 year)**

| Administration of forest | 4 × 4 Tractors |             |              |              |           |          | 4 × 2 Tractors |           |         |            |          |           | Skylines  |          |             |             | Total      |
|--------------------------|----------------|-------------|--------------|--------------|-----------|----------|----------------|-----------|---------|------------|----------|-----------|-----------|----------|-------------|-------------|------------|
|                          | Mb Trac 800    | Mb Trac 900 | Mb Trac 1000 | Mb Trac 1100 | Fiat 1180 | Unimog   | Steyr          | Ford      | Fordson | M.Ferguson | Tumosan  | Universal | Urus MIII | Gantner  | Koller K300 | Romork K300 |            |
| Adana                    |                | 3           |              |              |           |          |                |           |         |            |          |           |           |          |             |             | 3          |
| Adapazari                | 1              | 5           |              |              |           |          | 2              |           |         |            |          |           |           |          |             |             | 8          |
| Amasya                   | 2              | 10          | 1            |              |           |          | 6              | 1         |         |            |          |           |           |          |             |             | 20         |
| Ankara                   |                | 6           | 1            | 2            | 2         |          | 4              | 2         |         |            |          |           |           |          |             |             | 17         |
| Antalya                  | 6              | 10          | 1            |              |           |          | 3              | 3         |         |            |          | 1         | 1         |          | 1           |             | 26         |
| Artvin                   | 2              | 3           |              |              |           |          |                |           |         |            |          |           | 4         | 3        | 3           | 1           | 16         |
| Balikesir                |                | 7           |              |              |           |          |                |           |         |            |          |           |           |          | 2           |             | 9          |
| Bolu                     | 1              | 12          |              |              |           | 1        | 3              | 1         |         |            | 1        |           |           |          |             |             | 19         |
| Bursa                    | 2              | 5           |              |              |           |          | 3              | 1         |         |            |          |           |           |          | 2           | 2           | 15         |
| Canakkale                | 3              | 8           | 2            |              |           |          | 5              | 1         |         |            |          |           |           |          | 1           |             | 20         |
| Denizli                  |                | 1           |              |              |           |          | 1              |           |         |            |          |           |           |          |             |             | 2          |
| Elazig                   |                |             |              |              |           |          | 3              |           |         |            |          |           |           |          |             |             | 3          |
| Erzurum                  |                | 1           |              |              |           |          | 1              | 3         |         | 2          |          |           |           |          |             |             | 7          |
| Eskisehir                |                | 1           |              | 2            |           |          | 1              |           |         |            |          |           |           |          |             |             | 4          |
| Giresun                  | 6              | 9           |              |              | 1         |          |                |           |         |            |          |           | 2         |          | 1           |             | 19         |
| Isparta                  |                | 5           |              |              |           |          | 1              |           |         |            |          |           |           |          |             |             | 6          |
| Istanbul                 |                | 2           |              |              |           |          | 2              |           |         |            |          |           |           |          |             |             | 4          |
| Izmir                    | 1              | 6           | 1            |              |           |          | 3              | 3         |         |            |          |           |           |          |             |             | 14         |
| K.Maras                  |                | 3           |              |              |           |          |                |           |         |            |          |           |           |          |             |             | 3          |
| Kastamonu                | 5              | 11          |              |              |           |          | 2              | 2         |         |            |          |           | 5         |          | 1           |             | 26         |
| Konya                    |                | 1           |              |              |           |          |                |           |         |            |          |           |           |          |             |             | 1          |
| Kutahya                  |                | 2           |              |              |           |          |                |           |         |            |          |           |           |          |             | 1           | 3          |
| Mersin                   | 1              | 2           |              | 1            |           |          | 1              | 1         |         |            |          |           |           |          |             |             | 6          |
| Mugla                    |                | 7           |              |              |           |          | 1              |           |         |            |          |           | 1         |          | 2           |             | 11         |
| Sinop                    | 1              | 5           |              |              |           |          | 2              | 1         |         |            |          |           | 1         |          | 1           |             | 11         |
| Trabzon                  | 2              | 5           |              |              |           |          |                |           |         |            |          |           | 1         |          |             |             | 8          |
| Zonguldak                |                | 9           |              |              |           |          | 1              |           |         |            |          |           |           |          | 1           |             | 11         |
| <b>Total</b>             | <b>33</b>      | <b>139</b>  | <b>6</b>     | <b>5</b>     | <b>3</b>  | <b>1</b> | <b>45</b>      | <b>19</b> |         | <b>2</b>   | <b>1</b> | <b>1</b>  | <b>15</b> | <b>3</b> | <b>15</b>   | <b>4</b>    | <b>292</b> |
| <b>Gen. Total</b>        | <b>187</b>     |             |              |              |           |          | <b>68</b>      |           |         |            |          |           | <b>37</b> |          |             |             | <b>292</b> |

As of the end of 2003, the total forest area in Turkey is 20 703 122 hectares. This Figure is 26.6 % of Turkey's area. High quality forests and coppice forests spread over 10 547 987 hectares account for 50.9 % of the total forest area, coppice forests spread over 10 155 135 hectares account for 49.1 % of the total forest area. According to 2003 figures, the percent of coniferous forest in the total forest area is 53.9 and that of deciduous forest is 46.1. Production capacities are

approximately 12 039 718 m<sup>3</sup>/year in high quality forests and 8 837 705 m<sup>3</sup>/year in coppice forests, respectively [6].

Overall ratio of mechanization is relatively low. Approximately percentage of man power, animal power, machine power and skyline harvesting are 72 %, 15 %, 8 % and 5 %, respectively. The need for forest roads in total in Turkey was 201810 km and that 133693 km portion on which, corresponding to 66.25 % constructed by end of 2002 [7].

Mechanical park has been improved 187 MB Trac tractors, 68 farm tractors (adapted), 19 Koller K300 skyline, 15 URUS MIII skyline and 3 Gantner skyline machines as of 2004 as illustrated in Table 1.

### 3. Technical Features and Work Performance of Tractors

These tractors go into the yarder side with skidding roads and strips. In this areas tractors are used in two ways. The first way is; while tractors is staying on the road, to draw the product up to the road, which is found under the road or on the road, with the help of winch line. The second way is; to timber haulage the product directly on the surface, with skidding, while tractor is entering up to the yarder side.

MB Trac 800 – 900 – 1000 – 1100 tractor types are being used especially at mountain areas in Turkey. These tractors are showed technical features Table 2.

*Table 2. Technical features of MB Trac tractors*

| Features          | MB Trac 800          | MB Trac 900          | MB Trac 1000         | MB Trac 1100         |
|-------------------|----------------------|----------------------|----------------------|----------------------|
| Machine Power     | 75 HP (55 kW)        | 85 HP (63 kW)        | 95HP (70 kW)         | 110 HP (81 kW)       |
| Weight            | 6000 kg              | 6000 kg              | 7000 kg              | 9000 kg              |
| Drawing Power     | 60 HP (44,2 kW)      | 72,9 HP (53,7 kW)    | 76 HP (56 kW)        | 89 HP (66 kW)        |
| Speed             | 30/ 40 km/hour       | 30/ 40 km/hour       | 30/ 40 km/hour       | 30/ 40 km/hour       |
| Cylinder          | 4 cylinder           | 4 cylinder           | 6 cylinder           | 6 cylinder           |
| Cylinder Capacity | 3780 cm <sup>3</sup> | 3780 cm <sup>3</sup> | 5675 cm <sup>3</sup> | 5675 cm <sup>3</sup> |
| Cooling System    | Water Cooling        | Water Cooling        | Water Cooling        | Water Cooling        |
| Speed             |                      |                      |                      |                      |
| – front           | 25 – 40 km/hour      | 25 – 40 km/hour      | 25 – 40 km/hour      | 25 – 40 km/hour      |
| – back            | 20 km/hour           | 20 km/hour           | 20 km/hour           | 20 km/hour           |
| Vinch Mark        | CG2M2ZD              | CG2M2ZD              | CG2M2ZD              | CG2M2ZD              |
| Cable Diameter    | 12 mm                | 12 mm                | 12 mm                | 12 mm                |
| Cable Length      | 100 m                | 100 m                | 100 m                | 100 m                |
| Cable Speed       |                      |                      |                      |                      |
| – 540 tour        | 33/ 61 m/min         | 33/ 61 m/min         | 33/ 61 m/min         | 33/ 61 m/min         |
| –1000 tour        | 19/ 35 m/min         | 19/ 35 m/min         | 19/ 35 m/min         | 19/ 35 m/min         |
| Lift up Power     | 2000 daN             | 2000 daN             | 5000 daN             | 5000 daN             |
| Depot Capacity    | 120 lt               | 120 lt               | 170 lt               | 170 lt               |
| Machine Type      | OM 314               | OM 314               | OM 352               | OM352                |

In areas which has % 30-55 gradient, MB trac forest tractors can work comfortably. But farm tractors can work generally in areas which has a gradient until % 30. Weight and dimension of the product that is skidded by forest tractors, is more than the weight dimension of the product that is skidded by farm tractors. And also the movement capacity of forest tractors is higher than the movement capacity of farm tractors. Forest tractors have many axle height. Because of this they move more comfortably in skidding strips and roads. Yield values of work which had done with tractors and the study informations of machines are given in Table 3.

**Table 3. Data of the MB Trac and farm tractors in Turkey**

| Machines                        | Average Distance (m) | Average Output (m <sup>3</sup> /h) | Average Output (m <sup>3</sup> /day) | Average Fuel Consume (lt/h) | Average Slope (%) |
|---------------------------------|----------------------|------------------------------------|--------------------------------------|-----------------------------|-------------------|
| Pulling with cable              |                      |                                    |                                      |                             |                   |
| MB Trac 800                     | 50                   | 8,336                              | 66,688                               | 3-4                         | 48                |
| MB Trac 900                     | 50                   | 6,328                              | 50,624                               | 3-4                         | 53                |
| MB Trac 900                     | 30                   | 8,813                              | 70,504                               | 3-4                         | 35                |
| Steyr 768                       | 50                   | 4,382                              | 35,056                               | 3-4                         | 42                |
| Skidding on roads with tractors |                      |                                    |                                      |                             |                   |
| MB Trac 900                     | 100                  | 3,813                              | 30,504                               | 4-5                         | 10                |
| M Ferguson                      | 400                  | 6,360                              | 50,880                               | 5-6                         | 15                |

#### 4. Technical Features and Work Performance of Skylines

In Turkey, forest skylines are various types such as 1) Koller K300 skylines (300 m), 2) URUS MIII skylines (300-600 m), 3) Gantner skylines (1500-2000 m). Also, MB Trac 800-900-1000-1100 tractor types are being used especially at mountain areas.

If the distance of maximum 300 m, Koller K300 skyline makes a transport. If the distance is max. 600m, we use URUS MIII skyline and if the distance is between 1500 and 2000m, Gantner skyline is used for transport. Koller K300 skyline and Gantner skyline which is assembles to trailer, transport from below to above also above to below.

Skylines types are being used especially at mountain areas in Turkey. These skylines are showed technical features Table 4.

**Table 4. Technical features of Gantner, URUS MIII and Koller K300 skylines [8]**

| Technical features          | Koller K300     | Urus MIII             | Gantner         |
|-----------------------------|-----------------|-----------------------|-----------------|
| Base Machine                | Ford 1180 DTH   | Mercedes 1500T trucks | —               |
| Power of machine            | 50 HP           | 70 HP                 | 45 HP           |
| Maximum cable speed         | —               | 6 m/sec               | 7,5 m/sec       |
| Maximum skyline length      | 300 m           | 600 m                 | 2000 m          |
| Total weight                | 1600 kg         | 8500 kg               | 1420 kg         |
| Height of tower             | 7 m             | 8,7 m                 | —               |
| Brake type                  | Mechanic        | Mechanic              | Mechanic        |
| Maximum number of drums     | 2               | 4                     | 1               |
| Carriage                    | Koller SKA 1    | Koller SKA 2,5        | Koller SKA 2,5  |
| Cables (thickness × length) |                 |                       |                 |
| - Skyline                   | 16 mm/ 300 m    | 22 mm/ 600 m          | 24 mm/ 2000 m   |
| - Main line                 | 16 mm/ 300 m    | 12 mm/ 600 m          | 16 mm/ 2000 m   |
| - Guyline                   | 15 mm/ 3 × 30 m | 16 mm/ 50 m           | 15 mm/ 3 × 30 m |
| - Haulback line             | —               | 12 mm/ 1200 m         | —               |
| - Auxiliary line            | —               | 10 mm/ 600 m          | —               |

Koller and URUS skyline are mobile. Mounting and dismounting periods of these skylines are short. And also they are transported from a yarder side another very quickly. Mounting and dismounting periods of Gantner skylines are so long because of long institution and condition of lands. Koller and URUS skylines generally transport the product which is in the timber condition like this: One of the tip of product is transported in surface and the other is in hook by these skylines. But Gantner skyline transports the timber completely in hook. In to positions, average times of timber haulage works and yields of machines are shown in Table 5.

**Table 5. Data of the different skylines in Turkey [9]**

| Machines    | Average Distance (m) | Ortalama Yandan Çekme (m) | Average Output (m <sup>3</sup> /h) | Average Output (m <sup>3</sup> /day) | Average Fuel Consume (lt/h) | Ortalama Bir Sefer Süresi (dak) | Maliyet (\$/m <sup>3</sup> ) |
|-------------|----------------------|---------------------------|------------------------------------|--------------------------------------|-----------------------------|---------------------------------|------------------------------|
| Koller K300 | 225                  | 15                        | 2,889                              | 23,114                               | 2,5                         | 11,58                           | 4,49                         |
| Koller K300 | 150                  | 10                        | 10,012                             | 80,096                               | 2,5                         | 6,10                            | 3,48                         |
| URUS MIII   | 250                  | 11                        | 12,931                             | 103,448                              | 3,5                         | 5,30                            | 4,13                         |
| URUS MIII   | 350                  | 15                        | 7,906                              | 63,248                               | 3,0                         | 17,13                           | 5,24                         |
| Gantner     | 300                  | 20                        | 6,423                              | 51,384                               | 3,0                         | 12,12                           | 4,10                         |
| Gantner     | 800                  | 17                        | 2,234                              | 37,032                               | 3,0                         | 15,28                           | 5,06                         |



a) MB Trac 900



b) Gantner Skyline



c) Koller K300 Skyline



d) URUS MIII Skyline

**Figure 1. Tractors and skylines**

As it is show in the figure, it has been found that the yield of Koller skyline in % 20 gradient is 6,500m<sup>3</sup>/hour when the distance is 200m in average. But in average of 300 m distance, the yield of the skyline, has been found 5,250 m<sup>3</sup> per hour. Under these conditions, the fuel consumption of skylines change between 3 and 4 lt/hour. In skylines, average of 3-4 workers are worked according to land conditions of loading area, species of product which is timber hauled and the intensity of work in the ramp.

## 5. Conclusions and Recommendations

Cleaning the route of tractor, which makes drawing, from the obstacles and to make sufficient for drawing will be increase the yield of tractor. Choosing the ramp from nearer and wide areas also increase the yield of tractor.

During the cable hauling, when the distance increases, the yield generally decreases. Skidding the total condition of tree, is more difficult, when the distance increases. The cause of this is; total condition of trees pull other trees and stems in stand and this makes transport more difficult. And also it damages the product which is skidding. Because of this, it is more suitable to draw in the condition of timber for long distances.

During the skidding of product with the help of tractors, trees and sapling which are found in the environment and also soil of forest can be damaged. Because of this, if it is suitable, skidding strips and road must be opened in a place where the tractors are used. So, the roading in forest is increased but the drawing distance of tractors is decreased.

Skidding roads and strips must be done in a definite plan. These plans must be definitely suitable for an area and also practices must be put in order according to these plans.

A wrong way, which is followed in the stage of timber hauling, causes spending more power and more money and also spending more time in timber hauling. It also causes less amount and quality of product. In addition, it will be damaged the soil of forest and youth.

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