Acta Sci. Pol.
Silv. Colendar. Rat. Ind. Lignar. 7(4) 2008, 45-54

CAUSES OF DEFECTS OF POWER CHAINSAWS

Zenon Pilarek, Paweł Mielnicki
Poznań University of Life Sciences

Abstract. The article presents results of one-year long observations concerning the main causes of failures of power chainsaws of various manufacturers. The observations were conducted at two authorised service repair shops. It was found that new chainsaws subject to free guarantee surveys constituted the highest number of serviced devices. On the other hand, the principle causes of defects included: the feeding system and the body as well as the piston-crankshaft system (total of 50% of defects). The smallest number of defects was recorded in the case of the exhaust system followed by the starter system and elements of the work safety. The majority of defects resulted from the application of improper use of operational materials, incorrect usage and inadequate knowledge of users as well as discrepancies between the intended application of the analysed equipment and real operational conditions.

Key words: power chainsaws, defect causes, repairs

INTRODUCTION

The idea of tree felling and cross-cutting using appropriate machines is old and goes back the 19th century. However, it really came true only in the 20th century with the development of various kinds of machines and equipment for hand-machine work for timber harvesting reaching its most intensive development after the Second World War. Soon, chainsaws replaced completely hand saws. In the meantime, various kinds of machines for tree felling and processing (felling heads, processors, harvesters) came onto the market and, at the present time, their participation in forest works is growing very fast. However, high prices of the more sophisticated equipment cause that in Poland timber is still harvested, primarily, with the aid of power chainsaws. Thanks to their versatility, power chainsaws remain tools which are difficult to replace completely and despite their shortcomings, they will surely be used in forests for a long time to come.

Chainsaws can be classified according to various criteria and their considerable diversity meets the requirements of frequently very different customers. Among the crite-

Corresponding author – Adres do korespondencji: Dr inż. Zenon Pilarek, Department of Forest Technology of Poznań University of Life Sciences, Wojska Polskiego 71 C, 60-625 Poznań, Poland, e-mail: zpilarek@up.poznan.pl

ria often employed are: intended use, size (dependent of engine volume), number of operators, type of the engine, kind of the employed tool, distance of the tool from the engine [Pilarki... 2002].

As in the case of all such mechanical equipment, they require a definite scope of service if they are to work properly and are prone to various kinds of defects as well as ordinary operational wear. This study is an attempt to determine the main causes of failures of power chainsaws employed both by ordinary users for household purposes as well as by professional workers of enterprises rendering forest services.

The studies involved:

– analysis of guarantee repairs of power chainsaws,
– analysis of post-guarantee repairs of power chainsaws,
– analysis of the most frequent defects of power chainsaws,
– determination of defect causes.

The main criterion adopted to determine the reliability of power chainsaws comprised: the type and frequency of defects and breakdowns caused by their operation. The type and kind of damage, age of the equipment and conditions of operation made it possible to determine the reliability of individual groups of power chainsaws.

RESEARCH METHODOLOGY

Place of investigations

The study was based on investigations carried out at two authorised dealers of the Stihl Company at service workshops controlled by them. The service workshops, placed at approximately 30 km from each other, were situated in areas characterised by similar natural-forest and climatic conditions as well as economical conditions. Social and economical conditions prevailing in the region (large number of agricultural and agro-touristic farms which utilise the examined group of equipment intensively) favour the development of the discussed branch which causes that local residents use considerable numbers of this type of equipment which, in turn, finds its reflection in the number and structure of their repairs.

Method employed to carry out observations

Investigations were conducted using a questionnaire method for the period of one year beginning with the 1st of January 2006. This allowed getting a year-long picture of service works conducted in the above-mentioned service points. The year-long period of observations made it possible to assess variations in the intensity of different groups of equipment utilized for specific jobs.

The performed investigations involved the analysis of defects of power chainsaws produced by various manufacturers and continuous observation of their repair in service workshops. The questionnaire (called ‘repair card’) prepared in the form of a table contained the following columns:

– type and kind of equipment (make and model of the equipment),
– technical data (engine cubic capacity in cm^3, power in kW/hpm, mass in kg),

– date of accepting the tool at the service point,
– age of equipment,
– conditions of operation:
  • forest – the equipment used, most frequently, for timber harvesting in forests by professional operators,
  • home – the equipment used for various jobs around the house and in the garden by all members of the household,
– type of defect.

The basic pieces of information about the manufacturer, type, model and age of equipment were gathered from data found on the rating plate. In order to establish the precise period of use in specific conditions, information was provided by the owner of the equipment. The type of damage and the cause as well as the course of repair was consulted with service workers. Questions were also asked about the usefulness of a given piece of equipment, purposes for which it was used, its reliability, effectiveness and what considerations were taken into account when the choice of a given make was decided upon.

RESULTS

Table 1 presents data concerning the number of the repaired tools taking into consideration the classification according to manufacturers.

Table 1. Number and percentage share of devices of different manufacturers surveyed at the service points
Tabela 1. Liczba i udział procentowy urządzeń podlegających obserwacjom z podziałem na producentów

Producer – Producent	Pieces – Sztuk	Proportion, % – Udział, %
Stihl	348	66.03
Husqvarna	120	22.77
Partner	24	4.55
Dolmar	9	1.71
Mc Culloch	6	1.14
Stiga	6	1.14
Jonsered	5	0.95
Dolpima	4	0.76
Solo	2	0.38
Oleo Mac	1	0.19
Shindaiwa	1	0.19
Victus	1	0.19
Total – Razem	527	100.00

A significant majority of the examined number of machines comprised Stihl equipment (66%). This referred to both the number of models and number of individual tools and it is quite obvious bearing in mind the fact that the described investigations were carried out in the authorised workshops of this company. Within the confines of the area under investigations, there are also other authorised service workshops of the Husqvarna Company so it can be presumed that majority of equipment of this make finds it way there. However, despite this fact, nearly one fourth of the serviced chainsaws were products of the firm. During the analysed period of time, authorised Stihl workshops repaired also equipment of many other chainsaw manufacturers, among others: Partner, Dolmar, McCulloch, Stiga, Jonsered, Dolpima, Solo, which constituted 11% of all the investigated products (59 pieces) and which do not have authorised services of their own.

Taking into account the age of the examined devices, it can be noticed that 290 appliances, i.e. the most numerous group, did not exceed the age of 1 year, in other words they were subject to the guarantee inspection. Although they constituted the most numerous group of these devices, this fact cannot, by any means, be treated as indicative of the unreliability of this equipment. In most cases, the 'repair' consisted in, among others, regulation of the engine rotations as well as tightening of the clamping screws. Additionally, the purpose of the service inspection is to verify whether the equipment has been used properly. The observed high interest of users in the survey was due to the fact that it was carried out free of charge.

Defects of power chainsaws and their causes

In the case of the group of tools of power chainsaws, the performed investigations revealed that the most numerous among the repaired chainsaws were the defects of the feed system – over 26% as well as the piston-crankshaft system – nearly 25% of all the examined chainsaws (Fig. 1).

The feed system comprises the following elements: fuel tank, strainer with the fuel filter, fuel pipe supplying fuel to the pump, pump, carburettor and air filter. The principal role of this system is to supply to the engine cylinders appropriate quantities of the fuel mixture and air which should ensure a definite working conditions of the engine. An additional task of the system is to provide sufficient lubrication of individual elements of the engine because it is oil added to fuel that ensures its lubrication. The discussed system plays a very important role in the functioning of the investigated equipment by influencing the operation of the combustion engine and possible savings in the course of its operation. Maintenance of the proper condition of the feed system is fundamental for good achievements (efficiency) and possible low fuel consumption.

The following errors made by users are among the main causes of damages of the fuel system:

1. Application of inappropriate engine materials – incorrect fuel and engine lubricant as well as mixtures of wrong proportions.
2. Wrong regulation of the mixture in the carburettor – improper number of rotations of the crankshaft in the engine; inappropriate lubrication of its elements.
3. Poor care of the cleanliness of the equipment, in particular air filters and fuel; fouling of the fuel-air mixture; infiltration of dirt into the engine.

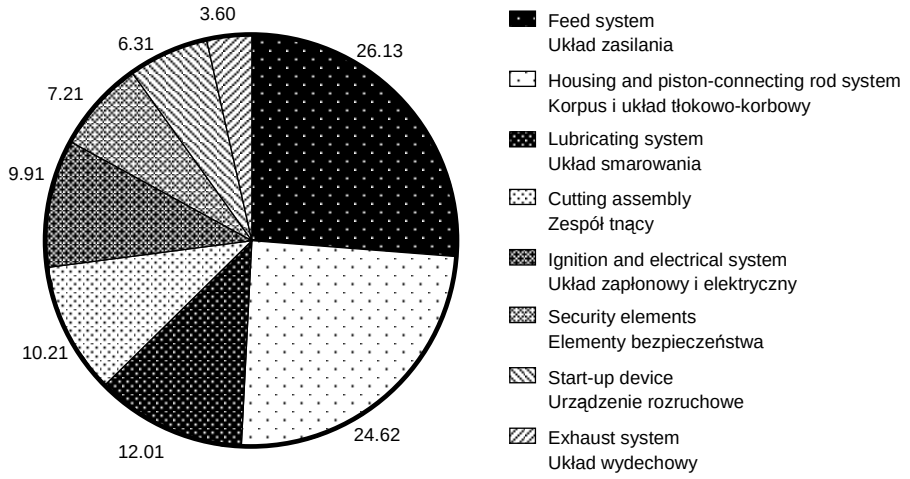

Fig. 1. Structure of damages of individual systems of power chainsaws
Rys. 1. Struktura uszkodzeń poszczególnych układów pilarek spalinowych

Majority of the recorded defects resulted from the users' mishandling or inadequate knowledge, but in the course of examination, it was also found that the cause of the failure of the feed system (carburettor and its elements) was poor petrol quality. The operator was an unwitting victim of fuel adulterated at petrol stations. Fuel contamination poses a serious danger to engines (Table 2). A similar threat is posed by water contained in fuel as it may cause disruptions in fuel supply. It is not uncommon for an engine in good state of repair to work unevenly and experience problems with start-ups. When fuel was poured into a glass vessel, phasing of benzene and water could be observed. Moreover, water found in the fuel may cause metal corrosion. The performed investigations revealed that the number of repairs resulting from the occurrence of water in fuel increased when a given group of devices was used after a long break in their usage, for example, the carburettor would break down after a longer break in the use of the chainsaw.

It should also be mentioned here that a failure of one system frequently results in the damage of another system which is somehow interconnected with the first one.

Apart from the feeding system, also the chainsaw body and the piston-crankshaft system frequently failed. The above-mentioned defects constituted nearly 25% of all repairs of power chainsaws.

The main elements of the chainsaw engine body include: the cylinder, one- or two-part crankshaft casing containing the crankshaft and the connecting rod. In turn, the piston-crankshaft system consists of the following elements: the piston, one or two sealing rings, the piston pin with rings blocking it, the connecting rod with a needle bearing in its head and the crankshaft with a roller bearing on the crankpin, with two ball bearings and sealing rings on the side pins to be fixed in the crank shaft [Pilarki przenośne... 2002].

Handling mistakes resulting in damages of the feed system were the main cause of the failure of the piston-crankshaft system. For example, unsatisfactory cleanliness of fuel filters and air as well as leakages in the feed system were the main causes

Table 2. Impact of fuel harmful components on the feed system and engine elements
Tabela 2. Wpływ szkodliwych składników paliwa na układ zasilania i elementy silnika

Sub-assembly Podzespół	Defekt Uszkodzenie	Symptoms Objawy
Fuel pipes Przewody paliwowe	damage and breaking of fuel pipes zniszczenie i pękanie przewodów paliwowych	fuel leaks, difficult engine start up wyciek paliwa, trudny rozruch silnika
Carburettor jets Dysze gaźników	jet clogging zapychanie dysz	difficult engine start-up, worsening of the engine dynamics trudny rozruch silnika, pogorszenie dynamiki silnika
Carburettor membranes Membrany gaźnika	damage of membrane surface, breaking uszkodzenie powierzchni membran, pękanie	erratic engine work, worsening of the engine dynamics nierówna praca silnika, pogorszenie dynamiki silnika
Combustion chaber Komora spalania	build-ups in combustion chamber osady w komorze spalania	decline of engine life, tendency for engine seizure spadek trwałości silnika, skłonność do zatarcia silnika
Piston Tłok	build-ups on piston heads osady na denku tłoka	decline of engine life, tendency for engine seizure spadek trwałości silnika, skłonność do zatarcia silnika
Lubrication system Układ smarowania	build-ups in the connecting-rod-piston system osady w układzie korbowo-tłokowym	decline of engine life spadek trwałości silnika

of impurities finding their way to the engine and, consequently, causing engine seizure. This led to costly repairs, usually the replacement of the piston and cylinder.

In the majority of cases, these types of repairs usually required replacement of damaged elements, such as: crankshaft bearings, piston seals as well as piston rings. This type of repair was performed on the highest number of chainsaws 3 to 6 years old in the group of professional chainsaws and more than 6 years of age in the amateur and universal category of chainsaws.

Similar percentage proportions of repairs in the total number of repaired chainsaws were observed in the case of the damaged lubrication system – 12%, cutting system – over 10% as well as the ignition and electrical system – nearly 10%. The lubrication system and the cutting assembly are characteristic for the group of power chainsaws which differentiate them from other tools.

Lubrication is necessary in places where friction of two surfaces occurs and, in the case of the examined group of tools, these are places of contact of the chainsaw links with the guide bar which belong to the cutting system. There are two reasons weighing in favour of cutting the quantities of oil used to lubricate the chainsaw without, at the

same time, impairing the condition of the entire cutting system: firstly environmental protection – practically all oil from the chainsaw cutting surface goes into the soil and secondly – economy. These two reasons were very often the main culprits responsible for the damage of the lubrication system. For 'economic' reasons, users carried out improper regulation of the oil pump and applied used oil from combustion engines, used gear oil or even edible oil. The above-mentioned oils did not have the required parameters as evidenced in 12% proportion in all defects.

The chain guide and the chain sliding along it are the two elements most exposed to loads and, at the same time, critical for the work efficiency of the tool. Badly sharpened or dull chains result in decline of work efficiency and increase of fuel consumption. A frequent symptom of improper chain sharpening is jerking of the chainsaw during work. The main cause of this phenomenon is the uneven filing off of the limiters resulting in uneven sawing of some chain links (some of then cut too deeply) and this causes the chain of the saw to jerk. A well-sharpened chain removes chips better.

It is fair to assume that, quite frequently, defects of the cutting system are 'repaired' by the user himself. The saw, guide bar and the clutch drum are those elements which, when damaged, should be replaced rather than repaired and such replacement does not require special service equipment but only proper tools and some technical skills. Naturally, repairs done at home are not always performed properly due to different levels of technical awareness and knowledge of users. Among frequent mistakes is the replacement by the user of one part without changing another part directly connected with the first one, for example, a damaged guide bar can easily destroy a new chainsaw.

Some elements of the cutting assembly such as: the brake of the chainsaw (band), chainsaw escapement and the repelling spur are associated, primarily, with the user's safety. Therefore, they were classified to a separate group, namely to the group of labour security which includes also the anti-vibration system: shock absorbers, chainsaw brake, accelerator button lock as well as the left and right hand protection guard. The proper technical condition of labour security elements exerts a very strong direct influence on the operator's safety. Labour security is exceptionally important in the case of this group of machines which are regarded as one of the most dangerous [Dąbrowski 2004].

Chainsaws which were brought to the service workshop were in continuous use, although they were not fully efficient (for example, their brake belt was broken). This type of defect does not affect directly the operational efficiency of the machine but it seriously decreases the safety of the operator.

Repairs of the security elements of chainsaws constituted 7% of the defect structure. It was observed in the course of the performed investigations that users became interested in repairs of these elements which was very encouraging as it showed growing awareness and care of users over their own safety and health.

Apart from the above-described defects, chainsaws with other defects were also delivered to the service workshop. These included: failures of the ignition and electrical system – 9.9%, starter – 6.3% and the exhaust system – 3.6%.

Damages of the ignition system comprised mainly the spark plug and the spark cap with the contact spring. As a result of wear, these elements are replaced by new ones and not repaired. At the present time, electronic ignition systems which, practically speaking, do not require any service are becoming increasingly popular.

The start-up activities initiate the work of the device. The component elements of a starter device include: flywheel (blower), starter ratchets, spring of the starter ratchets, cable return spring, cable, cable wheel and starter casing. Depending on the type of work, the start-up operation can occur quite frequently. For example, when the power chainsaw is used during timber harvesting, its engine can be started several time an hour. So depending on the intensity of the utilisation of a given device, a greater or smaller wear of individual parts of the starter may take place. Starter cable ruptures or collector damage were among frequent failures of this system. Very often, these defects were repaired by the operator himself.

The smallest group of failures of power chainsaws was the breakdown of the exhaust system – slightly more than 3.5% of all chainsaw repairs. The most frequent defects of this system included: burning of the walls of the exhaust pipe as well as loose mounting bolts causing knocking out holes of the exhaust pipe.

The problem of the assessment of the technical condition of chainsaws was investigated, among others, by: Ciesielczuk et al. [1998], Kusiak and Gorycki [2006], Skarżyński [2002 a, b], Stempski [2001] and Trzciński [1995].

Atypical defects

In the course of the performed analyses of chainsaw defects and their causes, attention was also paid to those devices which were brought to the service point because of non-typical damages. These were unique defects resulting from random events which are difficult to predict in normal working conditions. Their proportion in the total number of the repaired chainsaws was small but, due to their atypical and, at the same time, interesting nature, they are presented below:

1) fracture of the cylinder at the base – STIHL MS 310,
2) fracture of the crankcase casing at the cylinder – STIHL MS 270,
3) wear on the crankshaft caused by sealants – HQV 340,
4) fracture of the crankshaft at the connecting rod big end – 2 weeks after purchase (factory defect guarantee) – STIHL MS 270,
5) breaking away of the rear handle and the throttle lever resulting from the crashing of the chainsaw by a falling tree,
6) fracture of the crankcase casing and bending of the guide bar caused by a lorry running over the chainsaw – STIHL MS 390,
7) breaking off of the spark plug electrode which stuck into the piston head damaging the spark plug, piston and the cylinder – STIHL MS 390,
8) scaling off of the surface of ball bearings of the crankshaft resulting in the damage of the piston and cylinder – STIHL MS 270,
9) self-acting unscrewing of the bolt fixing the flywheel resulting in the breaking away of all blades and complete damage of the wheel – STIHL MS 270.

CONCLUSIONS

On the basis of the obtained results, the following conclusions were drawn:

1. One-year old machines brought to the service workshop for guarantee survey constituted the highest proportion of the examined devices. This group of chainsaws which

underwent survey was followed by two other groups, namely: chainsaws 2 to 4 years old (47%) and machines 6 to 8 years of age (28%). There was a dramatic drop in the numbers of chainsaws brought to the service workshop which were over 9 years old which can be attributed to the fact that there were very few machines of that age left operating.

2. A regularity was observed in the decreasing proportions of professional chainsaws in the total number of the examined machines with age.

3. The performed investigations revealed that the system that underwent breakdowns most frequently was the feed system and this could be attributed, primarily, to the poor quality and contamination of fuel.

4. Also the chainsaw housing and the piston-crankshaft system turned out to be relatively failure-prone – nearly 25% of all defects.

5. The exhaust and starter systems as well as elements of the labour security turned out to be most reliable. Repairs of safety elements constituted only slightly more than 7% of the repair structure. In the course of the performed experiments, users were observed to become increasingly interested in the repair of these elements. It was very encouraging to see growing awareness and care of users over their own safety and health.

6. Majority of defects resulted from improper handling and poor knowledge of users as well as varying degree of their technical awareness and culture.

7. Considerable number of defects also resulted from discrepancies between the intended use of the machine and actual working conditions. The improper choice of the applied equipment could frequently be attributed to economic factors.

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PRZYCZYNY USZKODZEŃ ŁAŃCUCHOWYCH PILAREK SPALINOWYCH

Streszczenie. W pracy przedstawiono wyniki rocznych obserwacji dotyczących głównych przyczyn uszkodzeń łańcuchowych pilarek spalinowych różnych producentów. Obserwacje prowadzono w dwóch autoryzowanych punktach naprawczych. Stwierdzono, że największą grupę serwisowanych urządzeń tworzyły pilarki nowe podlegające bezpłatnemu przeglądowi gwarancyjnemu. Natomiast główne przyczyny uszkodzeń dotyczyły układu zasilania oraz korpusu i układu tłokowo-korbowego (łącznie 50% uszkodzeń). Najmniejszą liczbą usterek odznaczały się: układ wydechowy, a następnie urządzenia rozruchowe oraz elementy bezpieczeństwa pracy. Większość uszkodzeń wynikała ze stosowania nieodpowiednich materiałów eksploatacyjnych, złej obsługi i niedostatecznej wiedzy użytkowników, a także z rozbieżności pomiędzy przeznaczeniem urządzenia a rzeczywistymi warunkami pracy.

Słowa kluczowe: pilarki spalinowe, przyczyny uszkodzeń, naprawy

Accepted for print – Zaakceptowano do druku: 13.11.2008

For citation – Do cytowania: Pilarek Z., Mielnicki P., 2008. Causes of defects of power chainsaws. Acta Sci. Pol., Silv. Colendar. Rat. Ind. Lignar. 7(4), 45-54.