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ENVIRONMENTAL SAFETY TRANSPORT OF HAZARDOUS GOODS BY RAILWAY

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Keywords: environmental risk assessment, hazardous goods, wagon
Abstract: Transport of hazardous goods by railway is not only particularly more sustainable, but is also faster than shipping and cheaper than air operations. But it is not always possible to use rail transport for the complete journey. The goal of big railway transportations companies is handle the pick-up and final delivery runs for customers and combine several means of transport to form multi-modal transport chains. Special case are hazardous goods, they are substances and articles that pose an acute risk to people, property and the environment due to their chemical or physical properties.

1 Introduction

European railway (Figure 1) markets have opened up a wide variety of prospects. As a result, it operates with individual wagon and block train services between all the countries in Western and Eastern Europe – and beyond the European Union too [1]. Railway transport is often the most sensible solution outside the EU. Shipments can often be handled faster by rail because customs clearance takes place during the journey; as a result, there are no waiting times at border crossings [2]. Mineral oil, gas, sulphur, carbonates and other chemical and fertilizer industry products are in safe hands with human life. This is because the project is specializing in transporting hazardous products by rail for the chemical industry, esp. wagon parking [2], [3]. Chemical goods are transported in single wagons, groups of wagons and block trains in strict compliance with domestic and international safety regulations. Many companies choose the important ports of the Europe (esp. Port in Antwerp) as their European distribution hub for their packed chemicals because of these five assets:

- customised logistics services,
- broad range of services,
- customer-oriented and cost-efficient customs procedures,
- transparent logistics chains,
- extensive transport network to foreland and hinterland [4].

The hazardous goods in the Port of Antwerp, esp. cargo handling, industry and logistics go hand in hand. The high level of integration and diversity throughout the value chain in Antwerp is unique in the world.

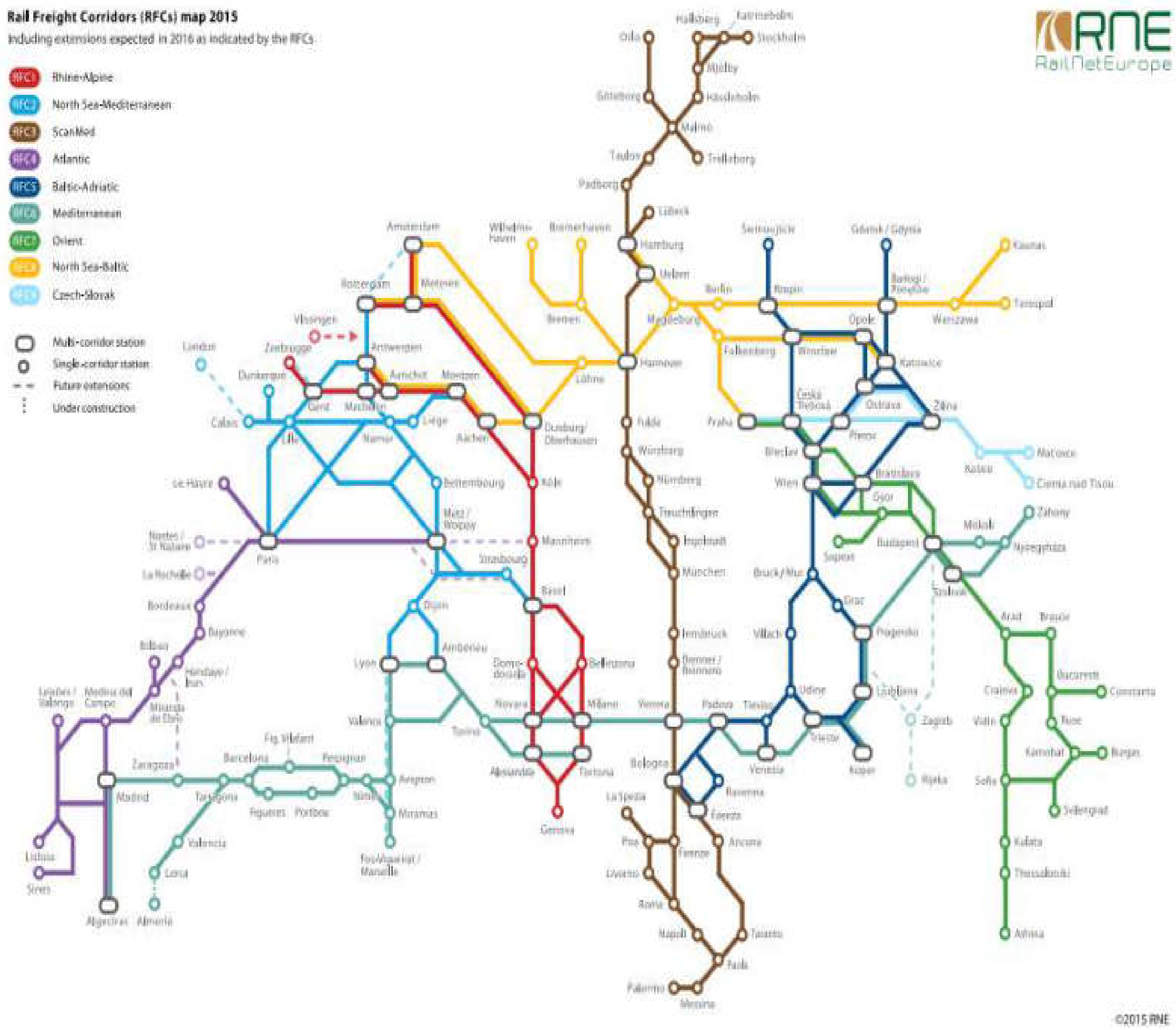

Figure 1 European rail freight corridors[3]

2 Legal conditions about environmental safety transport by railway

Every day thousands of tonnes of goods (esp. hazardous goods) are transported across the EU to factories, warehouses or final customers. Rail freight (and combined rail–road transport) is in direct competition with road haulage, shippers regularly compare the two when deciding which mode of transport to use [3]. They naturally choose the one which best suits their needs, taking mainly into account: reliability, price, customer service, frequency and transport time. In other words shippers choose methods of transport on the basis of business criteria, and not on the basis of EU policy priorities [4]. The design of the unit, as well as its constituents shall take into account the environmental conditions to which this rolling stock will be subjected to.

For each environmental parameter, a nominal range is defined, which is the most commonly encountered in Europe, and is the basis for the interoperable unit. For certain environmental parameters ranges other than the nominal one are defined [1], [3]. In that case, a range shall be selected for the design of the unit.

Depending on the ranges selected and on provisions taken appropriate operating rules could be necessary when the unit designed for the nominal range is operated on a particular line where the nominal range is exceeded at certain periods of the year. According to European court of auditors (in the special report of Rail freight transport in the EU), the rail freight corridors regulation already attempted to increase the transparency of the performance of rail freight services on freight corridors [5]. According to the regulation, performance indicators should be set at the level of each corridor, monitored every year and the results should be published in the corridors' annual reports. Moreover, the management board of each corridor is obliged to launch a satisfaction survey for the users of the freight corridor and to publish its results once a year [4]. However, our analysis shows that some limitations still persist.

3 Environmental railway safety control

The European Union Agency for Railways, formerly known as European Railway Agency (ERA), was established in 2004 to devise the technical and legal framework for creating a Single European Railway Area (SERA) as mandated under European Union law. ERA's core activities are creating a harmonised approach to safety, removing technical barriers, advancing the single European Train Control and Communication System (ERTMS), and promoting simplified access for customers for the European rail sector. With the entry-into-force of the technical pillar of the 4th Railway Package in 2016, the mandate of the Agency has been extended to that of a European authority, issuing rail vehicle authorisations, safety certificates, and approval for ERTMS infrastructure [4], [5]. After a period of legal transposition into EU Member State law, these changes are expected to take effect by 2019/2020. As is known, rail play an important role in creating a sustainable future for transport in Europe – and there is broad consensus that this should be so [6]. Rail transport may help to achieve essential policy objectives such as tackling climate change, fighting congestion, creating economic growth, contributing to the re-industrialisation on the European continent, and providing mobility to citizens of all ages and social backgrounds. Transport is the backbone of economy, and rail should be the backbone of transport. In order to play this vital role for society – I have said this on many occasions this year – rail has to solve its problem of cost and scalability, and take on innovation to improve customer services on and off board [3],[4],[6].

3.1 Locomotive/wagon protection systems

Various types of train (locomotive with wagons) protection systems (TPSs) are installed across Europe offering different functionalities and consequently various level of safety assurance. Among them, the automatic train protection system (ATP) is the most advanced type of train protection systems (Fig.2). It is considered to be the most effective technical measure that infrastructure managers can implement to reduce the risk of collisions and derailment on mainline railways. It enforces obedience to signals and speed restrictions by speed supervision, including automatic stop at signal [5].

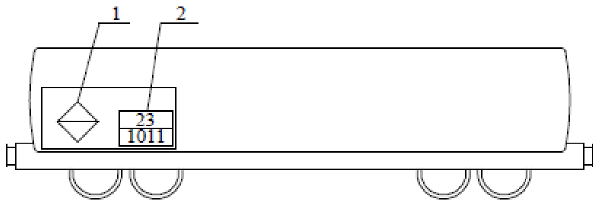

Figure 2 Chemical wagon (general scheme)

Legende:

1- alarm condition information,
2- security condition information

All Member States but three reported the presence of ATP systems on their railway network. However, the reported figures show a continuous problem of misclassification of different types of train protection systems. The Agency could verify the validity of reported figures in only a small number of them.[5] In these countries, the percentage of tracks equipped by ATP systems was generally under 20 %. Five Member States reported voluntarily a breakdown of figures for the different types of TPSs.[6] These figures suggest that TPSs with lower functionality (providing warning or warning and automatic stop only) are more common than ATP systems. In addition to reporting the percentage of ATP lines, almost all NSAs also reported the percentage of train kilometres on tracks with ATP in operation. This percentage is higher than the one of ATP lines, however for many countries there is surprisingly a relatively small difference, since one would expect intensive use of ATP equipped infrastructure, typically installed on lines with the highest traffic volumes [5], [6].

Conclusions

The rail network in the EU is generally designed for mixed traffic in other words, freight and passenger trains normally use the same tracks. For the rail network to operate, traffic management procedures have to be in place for allocating and managing paths. This is done individually by each infrastructure manager. The procedures are generally not adapted to the specific needs of rail freight transport, which is cross-border in more than 50 % of cases, even within the rail freight corridors.

Acknowledgement

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ORTHOTIC INFLUENCE OF LOCOMOTION AND VERTICALIZATION OF MYELOMENINGOCELE

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Keywords: HKAFO orthosis, myelomeningocele, locomotion
Abstract: The thesis explains orthotic influence of myelomeningocele – spine bifida, which depends on age, damage level and patient's disease. The main goal of this thesis is to evaluate the influence and effect of orthoses on patient's image of walking. HKAFO orthosis (an orthosis influencing the hip, knee and ankle joints and the foot) is designated for patients in need of stabilization or compensation, when the lower limb is paralyzed, but the strength of hip and partially of knee extensor is kept, or when the lower limb is completely paralyzed. Correct type of RGO allows the patient to walk faster and with less energy consumption. The goal of the orthosis application is verticalization in the most possible physiological standing and locomotion.

1 Introduction - Inication and construction of RGO

RGO – Reciprocal Gait Orthosis (Figure 1) – helps to alternate feet while walking. It belongs among the HKAFO orthoses and is often used when patient suffers from spinal cord damage, combines flexion in one hip joint with the extension of the other hip joint; it is also used by upper lumbar spine, while the active hip flexion is kept [1].

A typical RGO consists of bilateral KAFO orthoses with the offset of the knee joint (recently, mostly crural and femoral parts of full-contact made of plastic are used, whereas in the past also the conventional unilateral femoral parts of metal were used), knee joint with a lock, hip joints, skillet part dorsally extended to waist body part and of a controlling mechanism [2].

Figure 1 RGO orthosis

To the contraindications of reciprocal orthosis belong deficits in upper limb movement, insufficient muscle strength in the shoulder knit, loss of body mobility in frontal and sagittal level, massive skeletal deformities – scoliosis, hip flexion contracture of the hip itself (over 20 degrees), flexion contracture of knee joint (over 15 degrees), and torsional deformities of feet. To make the skillet movement possible and to imitate the physiological rotation by walking while using the orthosis, the double-axis construction of the joint is necessary. This makes patient's walk faster and with lower energy consumption. By use of one-axis joint construction, the image of walk is not physiological, however when using the double-axis joint construction, the feet stay turned in the way of walk [3].

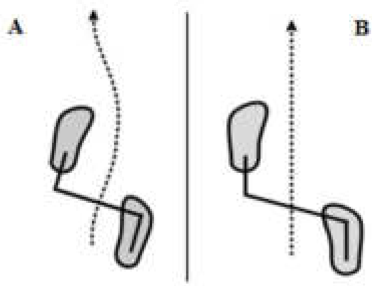

Figure 2 A – uniaxial joint B – biaxial joint

Reciprocal orthosis ensures the connection of skillet module with the splints of lower limbs. The result of double-axis joint construction is physiological rotation of skillet at walk, while not influencing the direction of walk, minimum energy consumption and effective step cycle.

The advantage of this orthosis is a system of two axes, which allows the skillet movement by 15 degrees while using orthosis. The direction of walk is not affected at all, and the body splints can be adjusted up to 10 degrees. The wired cable system helps by non-problematic power torque transfer at walk. However, the main condition for indication of this kind of orthosis is that the patient will be psychically capable to cooperate (Figure 2).

At the starting point, the feet are parallel in the frontal position. When the heel touches the ground and the skillet is rotated, the feet stay oriented in the direction of walking (Figure 3) [1].

Figure 3 Leg positioning at the start and end positions

Because of self-supporting pipe construction, the complete stability depends on the pelvis module (Figure 4). Thanks to exchangeable parts, the orthosis can "grow" with the child.

Figure 4 Pelvis modul with control mechanism

When using orthosis at walking, the movements are done reciprocally – due to this reason the two skillet joints are interconnected by double-action movement [1].

The skillet joints consist of sciatic joint and a joint for walking (Figure 1). These joints work independently from each other. When a patient sits, the joint for walking is blocked. When a patient walks, the sciatic joint is blocked [1].

Figure 2 Sciatic joint and joint for walking

The axis of the joint for walking is positioned with inclination of 35 degrees (Figure 3), so that the internal rotation of 15 degrees and external rotation of 15 degrees is ensured while the patient walks [1].

Figure 4 Axis joint with 35 ° inclination

The reciprocal orthosis can have the hip flexion set up to 10 degrees. The body splints are straight mounted and are allowed to adjust. The flexion in the hip joint helps to keep the optimal position of the skillet and of the waist

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lordosis, by which the waist spine is stabilized and straightened (Figure 5) [1].

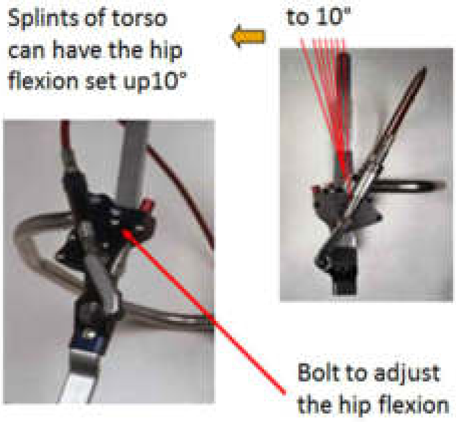

Figure 6 Splints of torso

When the release button is pressed, the seam joint closure mechanism is prepared for release and the click sounds. When the mechanism is prepared for release by a mistake it is possible to fix it back by pressing of the security button of the mechanism. Only in the neutral position, the sciatic joint can be released completely. By placing the parts of the lower joint into a parallel position, the joint for walking is locked. After that the sciatic joint can be released (Figure 7) [1].

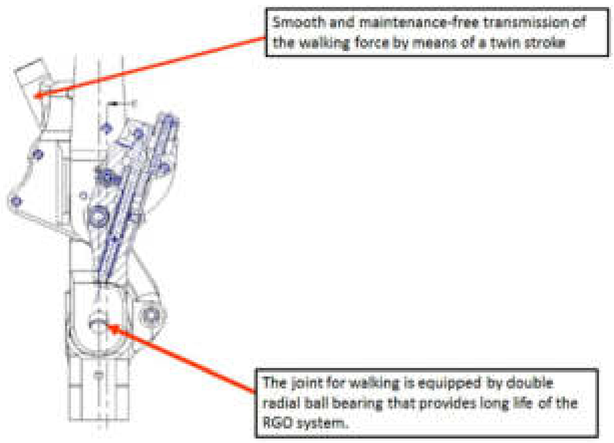

Figure 8 The function of the joint mechanism

2 HKAFO orthosis application

HKAFO orthosis was applied to a patient suffering from spine bifida, while the group of muscles controlling his foot was completely weakened. Muscles controlling the knee and hip joints are damaged as well. Both limbs are in extreme outer rotation. The knees turn into extreme hyperextension. The heels on both feet are in eversion, the forefoot is abducted and also the medial foot arch is lowered (Figure 9).

HKAFO orthosis is supposed to provide upright standing and allow the locomotion while using the walker. The orthosis consists of several components and modules. The feet are mounted in a laminate sandal (socket), which is interconnected with the crural socket by a modular multipurpose ankle joint. In this ankle joint the front stops are set. They prevent from ankle dorsiflexion and thus also from the knee flexion while transferring of weight in the standing position. In the back part of the ankle joint, the springs are placed to allow flexible treading on the heel and to help plantar flexion. Also the splint knee joints with the inserted rotation centre are used. These joints allow walking with a swing phase and they move in the anterior-posterior direction. They are connected with hip splint joint with free movement and in the proximal part they are mounted to body module. The hip joints are supposed to provide the movement and the stabilization in media-lateral direction. The body module is made from thermoplastics.

Figure 10 Verticalization before and after HKAFO application

Conclusions

The standing and walking mean maximum level of mobility and they increase the independence, thus also the self-consciousness of a child or a person dependent on a wheelchair use for a long time.

After the orthosis application, the locomotion with the help of a walker is achieved. This orthosis is particularly a rehabilitation aid, that allows verticalization and a walk to a patient using mostly the wheelchair. This verticalization is supposed to assist at better development of the skeletal muscular apparatus, and also of inner organs. Without the orthosis, the locomotion is laborious and complicated. People suffering from spine bifida have, due to their health status, different quality and versatility of their lives and this has also great influence on their personalities [4]. Therefore, the support from their direct environment, especially from the family, is very important for such patient. Also the work of the orthopaedic technician has a core value due to making of the correct aid. To help improve the quality of patients' lives, continuous development and refinement of all orthoses in particular, will be necessary.

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THE EFFICIENCY OF THE COGENERATION UNIT IMPLEMENTED IN THE CHS SYSTEMS IN TERMS OF HEAT GENERATION

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Keywords: CHS, cogeneration, heat, electricity, efficiency
Abstract: Presented paper is dedicated on issue of the operation of a cogeneration unit integrated in the central heating system. An evaluation of the efficiency of the cogeneration unit operation is performed during heat water preparation and later the heating season. Indicators are evaluated as the correlation between the primary fuel and the electrical and thermal energy consumption. The main idea is following combined generation of electricity and heat with look at efficiency of the cogeneration unit in the central heat supply system in terms of heat generation.

1 Introduction

Integration of renewable energy and cogeneration system for heat generation on the basis of act no. 309/2009 [1] becomes an important part of energy generation. This integration into the national heat and power generate network may be either as separate sources or as a part of central systems for the power and thermal energy generation. These changes are conditions for the implementation of directive of the European parliament and the council 2004/8/ES, which is and indispensable part of the development of the internal market of energy as well as measures of safeguard for electric energy supply. Within the development of energy systems primary support of cogeneration is based on the demand of usable heat. It is necessary to consider with the directive of the European parliament and of the Council of EU 2012/27/EU on energy efficiency, when implementing energy sources. Based on the development as mentioned in the [2] in the next years the greatest potential will be in the highly efficient heat and power generation sector especially in the segment of existing small and medium heat sources (heat plant, central district heating boilers) in which natural gas is incinerated by installation of combined heat and power technology with combustion engines.

The paper is devoted to the technology issue of integration the principle of cogeneration unit in multivalent systems of CHS (central heat supply) and consequently to increase efficiency of the source. The main purpose is to describe efficiency of the cogeneration unit operation integrated in the central heat supply system in particular periods of summer and winter season. According to the point that the natural gas is still assumed as the dominant fuel for heat production [3], cogeneration is a suitable source for high efficiency combined generation. The cogeneration system is usually designed and optimised according to economic and energy requirement with regard to environmental criteria and is usually autonomously controlled by microprocessors and current demand for energy.

2 Cogeneration in multivalent systems of central heat supply

The main idea of installing cogeneration unit in the central heat supply is to reduce energy costs, pollution and increase efficiency through the integration of renewable energy sources such as biogas and combined energy production. The production of heat and its delivery as final product is a sector whose operation is important not only from the aspects of industrial generation processes, but also from a social point of view. From the aspect of the generation of thermal energy for the final customer the advantage of the central heat supply compared to other forms are relatively low prices for heat, in connection with the increase of the usage of cogeneration. Negative influence on the size of the market with heat was also the disconnection of customers from central heat supply, which to the future is also not considered to such a big extent. Currently has been adopted legislative framework which establishes conditions for termination of sampling and practically making it impossible for customers to disconnect from heat sources using renewable energy sources [2] as stated in [3] the electric energy produced in combined production of heat and energy is exempt from taxes, if it is directly delivered to the final consumer of electric energy. It is possible to facilitate access to the electricity grid produced by high efficiency cogeneration on the basis of 2004/8/ES, in particular in the case of lowmpower cogeneration unit and micro cogeneration units. Development of the share of electricity production by high efficiency combined production to total electricity in Slovakia is shown in the figure 1.

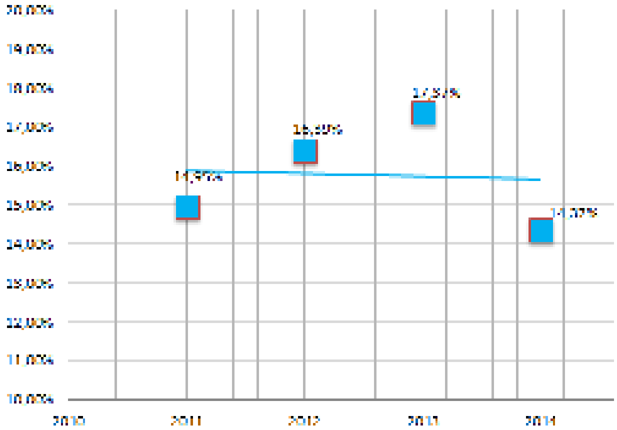

Figure 1 Percentage share of cogeneration electricity generation in Slovakia

The amount of primary energy savings and the amount of CO^2 savings achieved over the period 2011-2014 by high efficiency cogeneration are shown in the following graph.

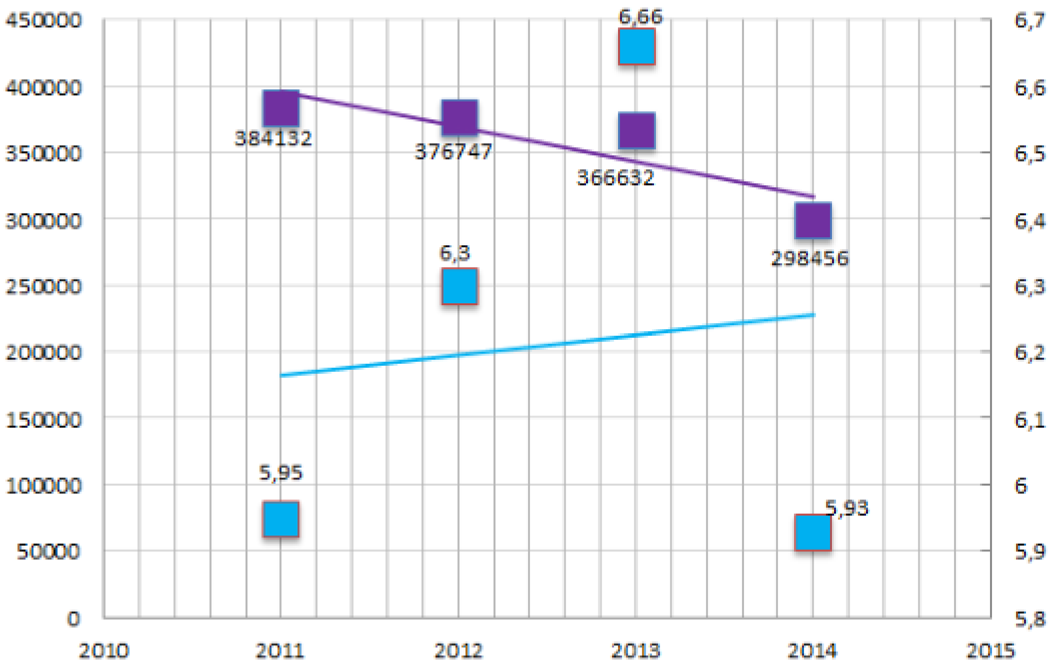

Figure 2 Amount of primary energy savings and the amount of CO2 savings

Heat supply nowadays requires part of the primary energy sources and the simplest way is to burn fuel and process generated heat then sends it to the customer. The efficiency of similar processes is high (80 to 100%), but fuel exergy is lost. Combined electric energy and heat production which represents cogeneration is energy more efficient way of obtaining heat. Figure 3 shows existing and assumed by the 2025 electric and thermal power of CHP (combined heat and power) plants according to the type of technology of combined energy generation [5]. The expected increase in electricity production in systems CHP using the combustion engines in 2025 predicts about 720% growth over 2011.

As shown in the following there is a direct correlation between generated electrical energy and produced heat. There is certain difference, due to the type of operation and the period.

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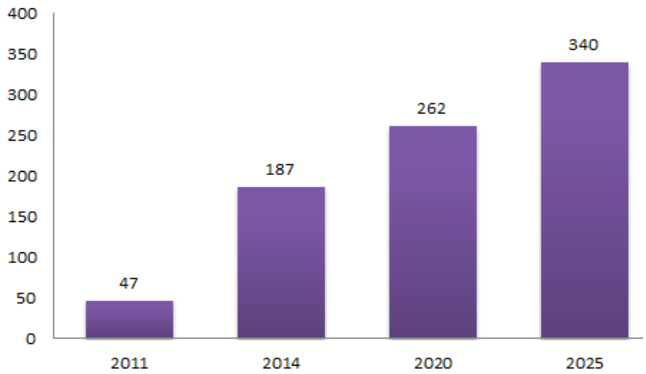

Figure 3 Increase of electricity generation in CHP systems

2.1 Combined energy production

Combined heat and power generation is one of the most efficient technologies to reduce primary fuel consumption and emission. The efficiency of combined energy production is described in fig. 4. The electrical efficiency of cogeneration unit is around 40 to 50%. The performance and operating time of cogeneration unit is limited by the operating hours during the summer season. In the winter season the cogeneration unit is operated 24 hours a day, during the summer season it is in operation for 18 to 19 hours a day. Increasing the efficiency of cogeneration unit from a physical point of view is not possible with current technology in the case of using the conventional fuels. However, there are several ways to increase efficiency one of them is integrating to it external RES (renewable energy sources) to make them multivalent systems of central heat supply.

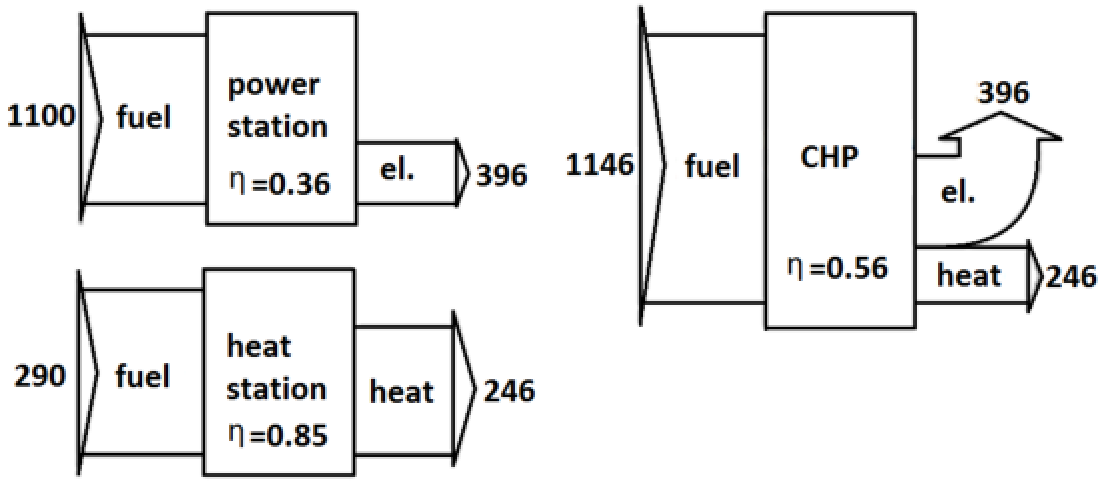

Figure 4 Conventional energy generation compared to combined energy

The main part of cogeneration unit is an engine that normally supplies an asynchronous generator. The engine itself consists of conventional carburettor for combustion mixed air and natural gas or various biogases. Each part of the cogeneration unit is placed in container with the noise and vibration reduction.

3 The efficiency of the cogeneration unit in the CHS

In order to carry out an evaluation of operational characteristics and efficiency is the selected cogeneration unit (Fig. 5) integrated within the CHS system. The cogeneration unit is operated in the primary mode of heat generation and it is production of electricity depends on the demand for actual heat production. The cogeneration unit in the given mode of operation provides heating and prepares hot water for approximately 1600 apartments, elementary schools and shopping centres located in its surroundings. The cogeneration unit itself consist of a gas combustion engine MWM/TCG 2016 V12C with a generator that provides 600kW of rated electric power and 650kW of rated thermal output. The electrical efficiency of this cogeneration unit is around 42,19%. The operating time of the cogeneration unit is limited by the operating hours (18 to 19 operating hours) during the summer. The actual operation of the device in this case is experimentally conditioned by the production of thermal energy. In the winter the cogeneration unit is operated 24 hours a day. The equivalent calorific value is added to the amount of fuel consumed.

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Figure 5 Container with cogeneration unit

3.1 Efficiency of energy production in individual seasons

The measurements were realised in winter and summer operating mode in 2016. As monitored parameters was quantity of consumed fuel for each period of time and the amount of produced heat and electric energy. After that conversions were made were determined the operational efficiency for heat and electricity production. Figure 6 shows the dependence of the energy produced on the fuel consumed.

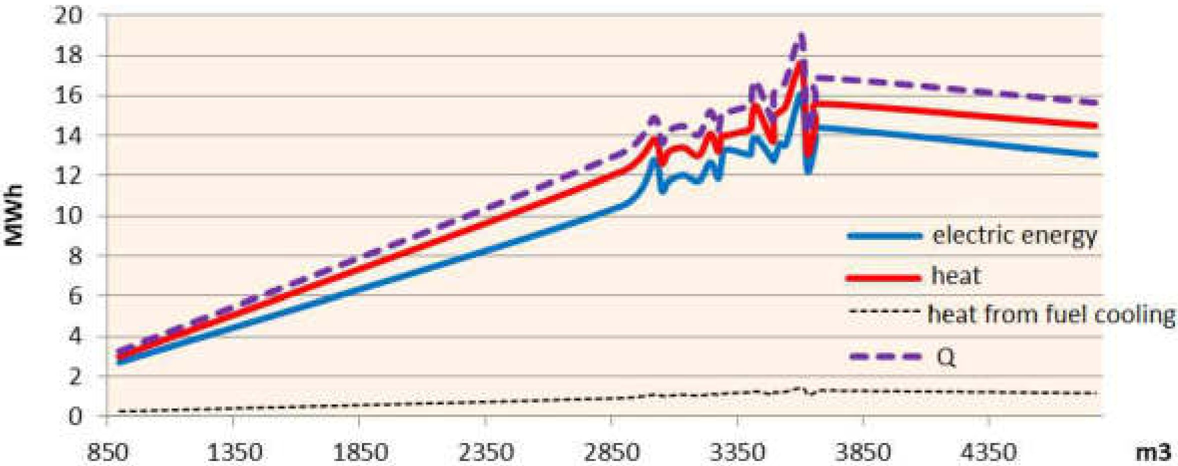

Figure 6 the dependence of the energy produced on the fuel consumed

On the basis of the modified equation for the monthly calculation of primary energy savings and the determination of efficiency, the thermal efficiency of cogeneration is the monthly generation of usable heat divided by the amount of input fuel used to produce the sum of usable heat and electricity through cogeneration; the electrical efficiency of cogeneration is determined as monthly produced electricity divided by the amount of input fuel used to produce the sum of the usable heat and electricity. The summary amount of the electrical and thermal energy produced by the cogeneration unit and divided by the theoretical value of the energy contained in the given amount of fuel, the percentage efficiency of the cogeneration unit is shown in figure 7.

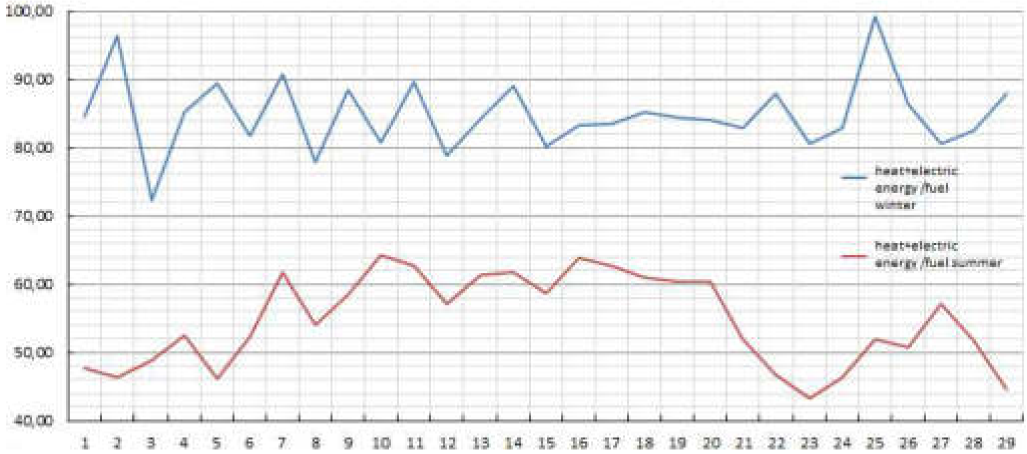

Figure 7 Comparison of efficiency in summer and winter season

The following figure describes the same but comparing with the previous one, it displays thermal and electrical energies separately. The priority of the cogeneration in this case is the production of thermal energy.

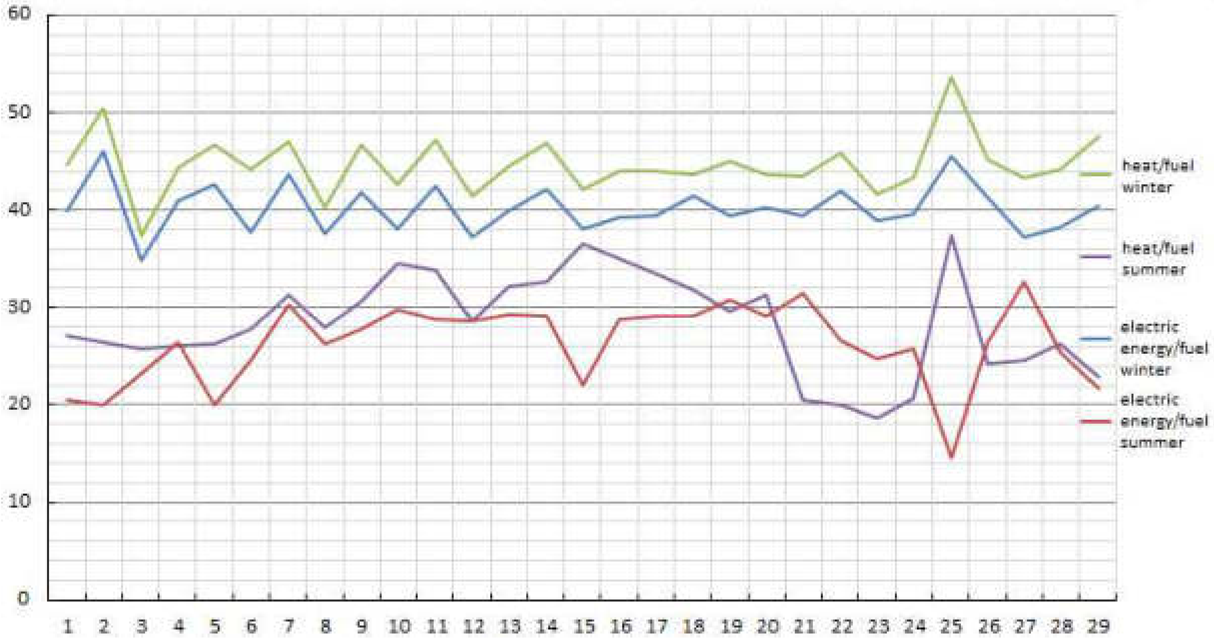

Figure 8 comparision of effieciency in summer and winter season - separatly

Conclusions

The assumed increase in electricity production in CHP systems using combustion engines in 2025 represents about 720% growth comparing with 2011, which represents a significant share in the ratio of heat produced by CHP equipment. As shown, there is a direct correlation between the generated electrical energy and the heat. However, there is a certain difference due to the type of operation and the period of operation. According to the point that the natural gas is still assumed as the dominant fuel for heat production, cogeneration is a suitable source for high efficiency combined generation.

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