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Research on the creation of a joint filler on the basis of a trailed tractor

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Abstract. This article is dedicated to the development of a joint filler for cracks in asphalt concrete pavement, as well as for expansion joints in cement concrete pavement. The article presents the choice of unified units and units of the joint filler unit being developed for cracks in asphalt concrete pavement and for expansion joints in cement concrete pavement. Some methods for calculating the main parameters of the created joint filler are presented. In addition, a suitable prototype of a joint filler, cracks in the asphalt concrete pavement and expansion joints in the cement concrete pavement were selected from several types.

1 Introduction

At present, the increase in the intensity of the traffic flow on public roads leads to destruction of existing roads, especially their carriageway, i.e. to cracks in the asphalt concrete pavement and the destruction of the expansion joints of the cement concrete pavement.

In this regard, every year the volume of road works on the above-mentioned defects of public roads is significantly increasing. Therefore, the development and creation of a joint filler for cracks in asphalt concrete pavement and expansion joints in cement concrete pavement is a very urgent task for the road industry of the Republic.

Modern joint fillers can be divided into two large groups. The first includes autonomous equipment that independently moves at speeds up to 40 kilometers per hour. Their power supply is provided by the built-in power plant. These devices are compact in size, so they are the best solution for use in confined areas. The second group includes trailed joint fillers based on TTZ trailed wheeled tractors. [1,2]

They work on the basis of a mechanical or energy system, which are characterized by an optimal combination of cost and quality, ease of use and ease of installation of interchangeable units and parts.

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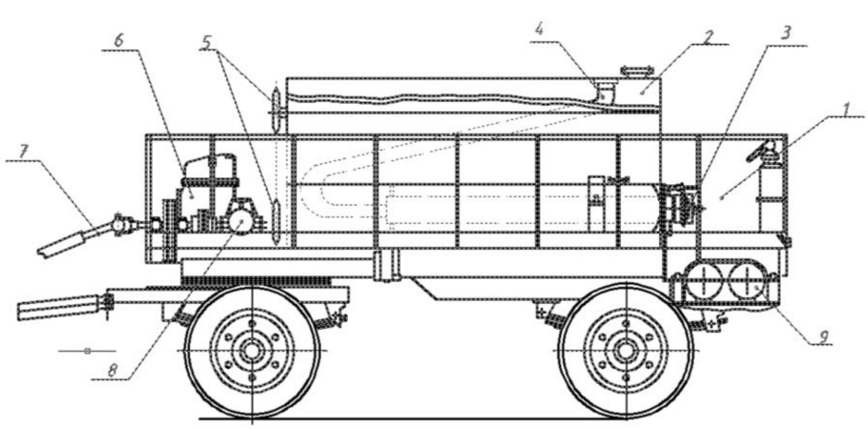

Fig. 1. General view of the trailed joint filler.

1-trailer, 2-tank for bitumen mastic, 3-bitumen heating system, 4-pipe for gas emission, 5-pulley, 6-compressor, 7-cardan shaft, 8-reducer, 9-gas cylinder.

It is customary to use joint fillers for heating, mixing and supplying under pressure the working mixture of bituminous mastic, for repairing cracks and pits, as well as road surface joints. They are also used on bridges, airfields and viaducts.

There are a number of important criteria for this aggregate , namely: [3,4]

– The volume of the bunker, that is, containers for storing and transporting the working mixture.
– Type of oil stirring device. It can be horizontal and vertical, equipped with a hydromechanical or hydraulic drive.
– Heating system. It can be gas, oil or diesel.
– Burner control - manual or automatic.
– The highest temperature of heating the working mixture.
– Engine type and parameters.
– Features of the distribution nozzle.
– Type of compressed air source.

Table 1. Technical characteristics of the G-1.0 gas burner with an air inlet.

Name	Value
Rated thermal power, MW	0.93
Nominal gas pressure, Pa	850±150
Consumption at rated load, m³/h	100
Rated air pressure, Pa	800±200
Burner control factor, not less than	3
Minimum excess air coefficient, no more	1.05
Nominal resolution in the furnace, Pa	20±20
Gas temperature in front of the burner, °C	from 0 to 30
Air temperature in front of the burner, °C	from 10 to 40
Overall dimensions, mm (length x width x height)	1140x280x280
Weight, kg	24

Fuel - natural gas with a net calorific value of 32-39.0 MJ / m³ and a Wobbe number of 38-53.0 MJ / m³

The trailed joint filler is developed on the basis of a 2- axle trailer 2PRTS-4.8. The main technological units and assemblies of the trailed joint filler being developed include:

– container for bituminous mastic and their components;
– bituminous mastic heating system: gas burner and gas cylinders;
– bitumen mastic supply system: unit for mixing bitumen and rubber crumb, compressor, receivers and pipelines;
– drive units: gearboxes, hydraulic motors, hydraulic pumps transmission mechanism (chain and belt);
– base tractor wheeled tractor TTZ-100.

Some characteristics of the mechanisms and components of the trailed joint filler.

2 Material and methods

Calculation of low pressure injection burners.

The initial data for the calculation are the thermal power of the burner, the chemical composition of the gas, the temperature of the gas and air, as well as the characteristics of the boiler plant for which the burner is intended. Calculation of the burners should provide the thermal power necessary for the installation, a wide range of gas flow control, flame stability without the use of artificial combustion stabilizers, the absence or permissible concentration of harmful substances in the combustion products. It includes determining the structural dimensions of the burner elements and the tunnel (or slot) or checking the ability of the selected burner to work under given conditions, as well as the required gas pressure in front of the burner. The hearth burner consists of two elements: a steel seamless pipe (collector) with holes drilled in it for gas outlet and a fire part.

The choice of a rational design of gas burners and their placement depend on:
– from the purpose of the unit;
– its thermal power;
– heating technologies and thermal conditions determined by temperature, uniformity and time of heating;
– requirements for the length and luminosity of the flame;
– features of the device of the working or combustion chamber.

A properly selected gas burner should provide:
– supply of the required amount of gas and air to the combustion zone;
– their good mixing;
– complete combustion of gas with a minimum coefficient of excess air;
– the necessary heat exchange in the working space of the unit, excluding local overheating;
- stable operation in the required range of changes in heat output .

Diffusion burners are used for burning natural gases in installations where a long luminous (smoky) flame with a uniform temperature along its length is required: open-hearth, cement, glass melting, etc. They are indispensable in high-temperature melting furnaces, where a stretched flame with a high degree of blackness is required. In cast-iron sectional boilers, TVG boilers, dryers and other units with a vacuum in the furnace and reserve fuel - coal, low-pressure hearth burners PG-N can be used.

In the same installations, low and medium pressure prechamber burners can be used. For quick transfer of boilers from gas fuel to solid fuel and vice versa, vertical slot burners with forced air supply are used.

Boilers DE, TVG (KVG) and other thermal units of similar heat output are equipped with bottom adjustable medium-pressure burners PGOD-S, PGD-S with a forcedly developed theory of injection of a free jet flowing into a fixed space.

The calculation of such burners is reduced to determining the size of the burners. The initial data for the calculation are: the estimated hourly consumption of combusted gas V_r, m^3/h, or the nominal heat output of the burner Q_g, MW; nominal gas pressure P_g in front of the burner nozzle, Pa; primary air injection coefficient α'; chemical composition and heat of combustion of gas Q_n, kJ/m ^{3}; gas density ρ_o, kg/m ^{3}.

On steam water tube boilers DKVR, DE, KE and E, it is effective to use Weishaupt mixing burners with a short flame (SF version) [27]. The burners are designed to operate on the following types of fuel: natural, oil and associated gas (type G); fuel oil and crude oil (type MS and RMS); their combinations (type RGMS); diesel fuel (type L and RL); combinations of gas and diesel fuel (type GL and RGL). Weishaupt burner power from 720 to 18000 kW, natural gas pressure from 13 to 4000 mbar (0.0013–0.4 MPa).

Weishaupt burners on these boilers instead of mixing burners GM, GMGm , GMP, RGMG increases the efficiency by 2.5–3%; allows to apply systems of smooth frequency and oxygen regulation; increases the control range (on average 1: 7); ensures uniform distribution of the torch throughout the combustion chamber of the boiler; increases the service life of the boiler by 2.5-3 times; reduces the content of nitrogen oxides in combustion products by 1.5–2 times; increases the level of automation through the use of microprocessor control systems; improves the convenience of maintenance and operation due to the block design of the burners (the block includes all the elements necessary for the preparation and supply of fuel to the combustion zone, devices for automatic control of the combustion process and emergency protection).

The calculation scheme of the burner is shown in fig. 2.

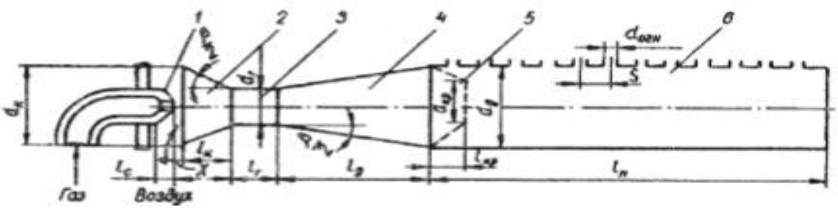

Fig. 2. Scheme of a low pressure injection burner.

1 - nozzle; 2 - confuser ; 3 - neck; 4 - diffuser; 5 – crater; 6 - nozzles.

Cross-sectional area fc and nozzle diameter dc are determined by the formulas:

$$f_c = \frac{V_{\text{Г}}}{3600 \cdot \varphi \sqrt{\frac{2}{\rho} \cdot P}}, \text{ m}^2 \tag{1}$$

$$d_c = \sqrt{\frac{f_c}{0,785 \cdot n_c}}, \tag{2}$$

where , V is the calculated gas flow rate of the burner, m ^{3} / h; P is the gas pressure in front of the burner, Pa; ρ_o - gas density under normal conditions, kg / m ^{3} ; n_c is the number of nozzles in a multi-nozzle burner; φ is the consumption coefficient, taken according to table 1.

Table 2. Flow Rate Values for Cylindrical Nozzles

$\frac{l_c}{d_c}$	0	0.18	0.36	0.45	0.56	1.13	2.26	4.52
φ	0.70	0.75	0.84	0.88	0.90	0.88	0.87	0.83

The diameter of the multi-flare nozzle is assumed to be equal to the outlet diameter of the low-pressure diffuser.

3 Results

To heat bituminous mastic, a heating system has been developed, which includes a special gas heating system, through gas burners GKS-2.5.

Characteristics of the gas burner GKS-2.5.

1. Thermal load, kcal / g - 16150
2. Gas consumption, m ^{3} / h at Q $_n$ \u003d 8.5 kcal / m ^{3} - 1.9.
3. Nozzle diameter d $_{with}$, mm - 3.8
4. Hole diameter d $_1$, mm - 5.5.
5. Burner length L , mm - 830.
6. Number of gas outlets, pcs - 43.
7. Mass of the burner, kg - 4.6.

The set of the joint filler unit includes containers for bitumen emulsion for wetting the edge of the asphalt concrete pavement when repairing cracks.

The joint filler unit is equipped with unified units for driving existing gearboxes, a compressor for the pneumatic system of the main tank. Usually bituminous mastic gives in under pressure of about 2 ... 2.5 kg / cm ^{3} . Belt and chain drives, worm and bevel gears, etc. were used.

The required power of the pneumatic system is determined by the ratio of the drive power of the compressor to the useful power of the compressed air consumer: [1,3]

$$N_{pr} \backslash u003d \frac{N_{пв}}{\eta_{пв}} \quad (3)$$

where, $N_{пв}$ is the required compressor power, kW; $\eta_{пв}$ - useful power of the air consumer.

The effective power of the pneumatic system is determined by the formula:

$$N_{eff\,(pv)} \backslash u003d\, N_{pr} \cdot \eta_{pv} \quad (4)$$

$N_{eff\,(pv)}$ - the effective power of the air consumer, this is the sum of the capacities of all air consumers is equal to:

$$N\ eff\ (pv)\ \backslash u003d\ N\ v1 + N\ v2 + N\ v3 \quad (5)$$

where, $N_{в1}$, $N_{в2}$, $N_{в3}$ is the effective power of each air consumer.

The required nominal pressure of the compressor is found from the maximum value of the nominal pressure of all air consumers. For the pneumatic system of the trailed joint filler, we accept the nominal pressure: P_{nom} = 0.7 MPa. According to the results of the calculation, we accept the compressor brand U43102A. This compressor is mainly widely used in the DSM pneumatic system .The U43102A compressor is used in ambient conditions at temperatures from -40 °C to +40 °C, with air humidity up to 80%. The main technical characteristics of the compressor: Productivity - 31 m ^{3} / hour; Rated number of rotation of the crankshaft - 1300 rpm; Power (required) - 4.2 kW; Overall dimensions, mm: length - 400; width - 360; height - 555; Compressor weight, kg - 67 kg.

The air flow rate in the pipeline is determined by the formula:

$$\vartheta = \frac{Q \cdot 1000}{6 \cdot f} \quad (6)$$

where **,** Q - air consumption, m ^{3} / min; f - cross-sectional area of the pipeline, cm ^{2} ; ϑ– air flow velocity, m/s.

The conclusion is that the selected compressor has an air flow within the allowable range of portable compressors.

4 Conclusion

As a result of the study, the main design features of the joint filler unit being created for cracks in the asphalt concrete pavement and for expansion joints in the cement concrete pavement were identified. The choice of unified units and units of the joint filler unit being developed for cracks in the asphalt concrete pavement and for expansion joints in the cement concrete pavement was made. Some methods for calculating the main parameters of the units of the developed joint filler are presented.

References

1. V. V. Artikhovich, E. A. Volchek, *Calculation of gas burners* (BNTU, Minsk, 2015)
2. M. S. Maksudov, *Development of seam bays, asphalt concrete pavement and expansion joints cement concrete pavement. Aviation and space technologiescience and science dolzarb muammolari* (Tashkent, 2022)
3. K. K. Shestopalov, *Construction and road vehicles* (Academy, Moscow, 2008)
4. V.I. Balovnev, G. Kustarev, et. al., *Road-building machines and complexes* (Publishing Seabadie 's house, Moscow, 2001)
5. A. V. Vavilov, A. M. Shmelev, D. I. Bochkarev, et.al., *Machines for the maintenance and repair of roads and airfields: Proc. allowance* (BNTU, Minsk, 2003)
6. A. M. Shemelev, V. M. Pilipenko, A. V. Vavilov, *Machines for public utilities* (Strinko, Minsk, 2003)
7. V. A. Dovgyalo, *Machines and equipment for the maintenance of highways* (BelSUT, Gomel, 2016)
8. P. V. Shepelina, M. Y. Chalova, A. V. Mishin, *Construction and road machines* (2017)
9. V. N. Tarasov, I. V. Boyarkina, M. V. Kovalenko, Construction and road vehicles **1**, 28 (2003)