Polish-Type Water Pulsated Jigs

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Abstract

The purpose of this paper is to review recent designs of polish water pulsating jigs in last years. This article shows basic technical parameters of polish jigs on the basis of its high capacity per unit with high imperfection in coal preparation plant or high efficiency separate gravel and sand in mineral preparation plant. The adoption of a computer-controlled system in the design of the jigs have provided several advantages, for example control of water pulsation within any selected cycles, automatic control over the collection of the bed, automatic control over the loosing of the bed, relatively low costs of cleaning and its overall "clean" technology with potential ability to reuse "waste" [3, 5]. The latter aspect of coal or gravel and sand preparation is particularly important for environment protection.

Keywords: hard coal, gravel, sand, gravity beneficiation, imperfection

Introduction.

The design of such jigs has undergone complete modification, insomuch that the original OBM type (the Baum jig) has been changed to the OM KOMAG-type, a jig with water and air chambers positioned under a sieve screen. The modifications have includes changes in the geometry, improvements in the facilities for receiving heavy products, a new designs of pulsator valve and the replacement of mechanical drives by hydraulic, electrohydraulic and electro-pneumatic versions. The introduction of an electronic control system has also made a real contribution to the automation of the cleaning process. Different types of jigs which had been operated in polish coal preparation plants since 1960 were gradually replaced by newer types of pulsating jigs. At first, these introductions were OBM-type machines to be followed later by units of the OM-type, characterized by the use of a mechanically-operated control system for receiving of heavy products. In the later versions, the level of the heavy product layer was measured by means of floats, the impulse from which was transmitted to a servomechanism system which actuated the opening of a discharge gap, using a hydraulic mechanism. The control now employed makes it possible to maintain a constant preset thickness of the heavy product. A float transmits impulses, corresponding to the height of the separation layer, to an electronic system in a contactless mode. As a result, the collection of tailings and middlings is immediately initiated by means of an electrohydraulic driving system. In the 1970's the pulsatory motion of the water, previously generated by the metering valves used to supply the air to the water and air chambers, was obtained by the use of rotary valves. Their designs ensured that the character of the cycle was kept constant. In the 1980's, the rotary valves were replaced with disc valves, which operated according to an electronically-controlled cycle. At the same time, the design of the rotary valves was the subject of continuous improvement [4]. The result was the introduction of the so-called multiphase cycle, presented in Fig. 1.

The adoption of a computer-controlled system [1, 2, 15] in the design of the jigs, together with the use of pneumatically-driven pulsatory disc valves, electrohydraulically-activated throttling valves controlling the working air have provided several advantages:

- control of water pulsation within any selected cycles,
- automatic control over the collection of the bed,
- automatic control over the loosing of the bed,
- obtain automatic control of the air pressure in a collector,
- automatically control the under screen water inflow,
- achieve automatic control of the ash content.

Technical progress in the mechanization of coal processing over the years has resulted in a continual increase in the yield of fine-grain fractions within the total weight of run-of-mine coal. The recovery rate of so-called fines, ie in the 20-0 mm grain size, within the total volume of coal is up to 75%.

In Poland, almost the only machines which find application in the cleaning of fines are pulsating jigs [8]. Such units are also of prime importance in the operation of coal preparation plants worldwide. This is because of the universal nature of the equipment which provides for the cleaning of a wide range of grain sizes, at relatively low cost, compared with the other coal preparation systems. Jigs are used to clean coal within a broad spectrum of grain sizes, eg 100-1 mm, 70-0,5 mm and 50-0,5 mm. Such machines can also cater for grain sizes of 20-0,5 mm, 13-0,5 mm and 10-0,5 mm, and in the case of coal containing sulphur-rich impurities, between 25-3 mm or 10-02 mm where the fin-

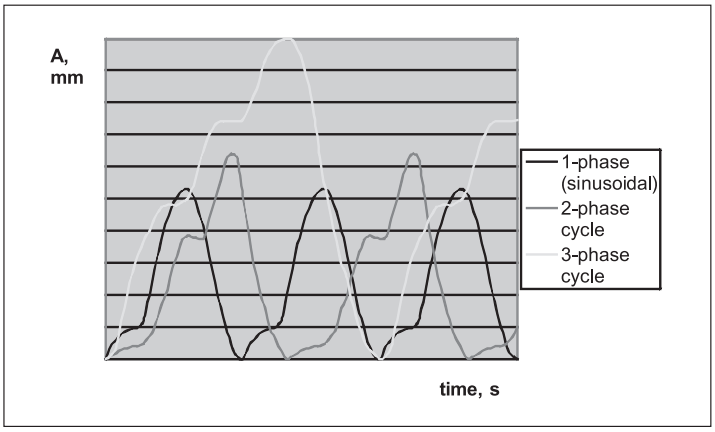

Fig. 1 Multiphase cycle of pulsating water (rotary valves) [6]

Rys. 1 Cykl wielofazowy pulsacji wody (zawory obrotowe) [6]

est fraction (below 2 mm) requires separate cleaning in heavy medium cyclones, hydrocyclones or in spiral separators [11]. Despite the availability of different designs of separators, pulsating jigs are still finding wider and wider application in coal preparation plants. It is also possible to apply the electronic control system to jigs fitted with rotary valves. However, in this case, the pulsation cycle parameters cannot be electronically controlled. The present state of technology allows jigs to be selected, and if necessary designed, for any type of coal, and for any capacity, depending on the requirements for a specific mine. The results of the work in KOMAG Gliwice were used in pulsated jig, designed to separate the sand-and-gravel feed into two products of grain sizes of 32-2 (0) mm and to separate mineral and organic impurities from the obtained aggregate [9, 10].

Possible Improvements in the Jigging of Run-of Mine Fines

One main factor has emerged from the investigations carried out, over many years, into possible procedures which might lead to the improvement of jigging. This is the need for the correct selection of the characteristics of the water pulsation cycle to match the specific type of coal which is to be cleaned. For example Fig. 2 presents trapezoidal characteristic of pulsating water [6].

This choice has an essential effect on the process parameters. It is of even greater importance when meeting the combustion requirements for fines containing sulphur. Another factor to be considered is the correct specification of the sieve deck, the apertures of which should be correlated with grain sizes and the densimetric parameters of the material to be cleaned. The above elements have a direct influence on the correct transportation of the feed, the amount of grains passing the screens, water requirement, and the quantity and pressure of the working air needed to operate the process [7]. When all the above conditions are met, and with the stability of the feed during the cleaning cycle assured, the quality of the product will be considerably enhanced.

For example design of PROREM-type pulsating jigs OMD3-4x7,5, shows in Fig. 3 and Fig. 4 for new hard coal preparation plant in LW BOGDANKA coal mine have the adoption of a computer-controlled EMAG-type system BOSS2010 shows in Fig.5. The jigs have provided several advantages, for example control of water pulsation within any selected cycles (trapezoidal), automatic control over the collection of the bed and automatic control over the loosing of the bed [14].

The Preparation of Gravel and Sand in the Water Pulsated Jigs

This point presents the equipment for the removal of impurities from sand-gravel aggregates. The amount of impurities in mineral deposits of aggregates have been presented, along with the effective methods of impurities utilization as a resource. The water pulsated jigs polish-type are designed to separate the sand-and-gravel feed into two products of grain sizes of 32(16)-2(0) mm and to separate mineral and organic impurities from the obtained aggregate. An operation of the jig is based on a typical gravity separation of minerals and consists in a stratification of suitably prepared feed in the water pulsating environment, according to components size analysis and density. Proper operation of the jig is guaranteed by the electronic control system, which enables to control the water pulsation characteristic as well as the collection of washed gravel. Additional equipment of the jig is as follows: screw compressor and air blower. Rated output of the pulsated jig, which depends on sand content in the feed (max. 35 %), for the operational surface of 4 m2 is 80–100 Mg/h. In-

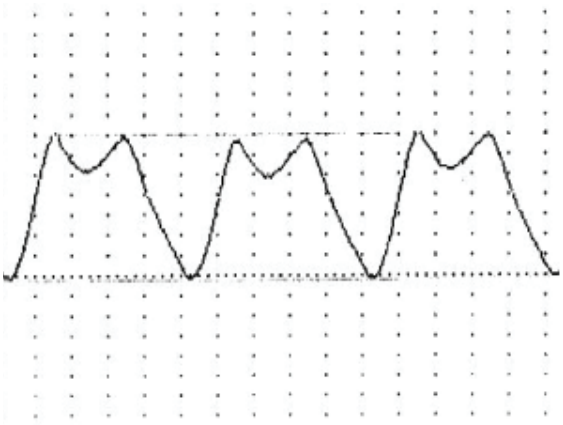

Fig. 2 Trapezoidal characteristic of pulsating water (disc valves) [6]
Rys. 2 Cykl trapezoidalny pulsacji wody w osadzarce (zawory talerzowe) [6]

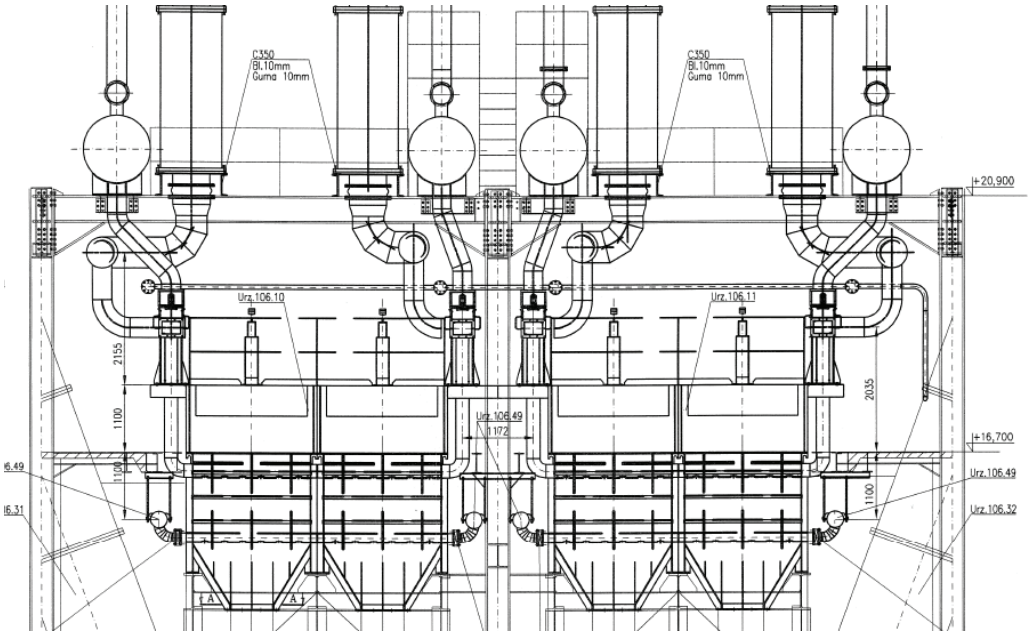

Fig. 3 Pulsated jigs OMD3-4x7,5 in LW BOGDANKA [14]
Rys. 3 Osadzarki OMD3-4x7,5 w LW BOGDANKA [14]

Fig. 4 Pulsated jigs OMD3-4x7,5 in LW BOGDANKA [14]
Rys. 4 Osadzarki OMD3-4x7,5 w LW BOGDANKA [14]

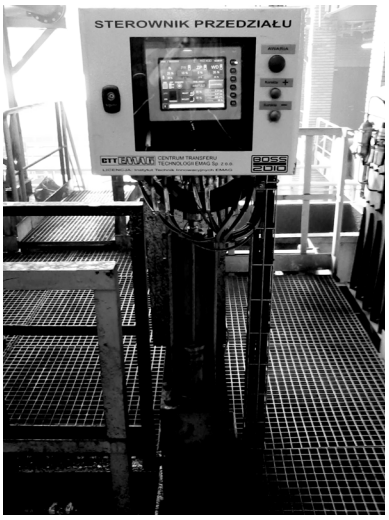

Fig. 5 Computer-controlled EMAG-type system BOSS2010 in LW BOGDANKA [14]
Rys. 5 Sterownik EMAG BOSS2010 w LW BOGDANKA [14]

Fig. 6 Pulsated jig K-100 in Januszkowice preparation plant
Rys. 6 Widok osadzarki K-100 w Żwirowni w Januszkowicach

novative electronic control system MICRO-type (SES) enables to select the water pulsation characteristics, depending on technological parameters of the feed by use of electro-pneumatic drive (pulsated drive), as well as controls the gravel collection by electric pulses provided by the float sensor [12]. Fig. 4 presents pulsated jig K-100 in CEMEX Januszkowice preparation plant.

Technical Parameters of Polish Jigs for Hard Coal Beneficiation and for Gravel and Sand Preparation

The jigs becomes fully competitive with other types of gravity separators, on the basis of its high capacity per unit, relatively low costs of cleaning and its overall "clean" technology [12, 13]. Technical parameters of polish jigs type OM, OS and OZ for coal beneficiation presents Tab. 1. Technical parameters of polish jigs KOMAG-type K for gravel and sand preparations presents Tab. 2.

Summary

This paper describes the progress which has been made over the last years in development of pulsating water jigs for the beneficiation of hard coal or gravel and sand. It shows that a number of design improvements, including a new pulsator valve and the introduction of advanced drive systems, coupled with an electronic control system, have dramatically improved throughput and efficiency of jigs. The adoption of a computer-controlled system in the design of the jigs, together with the use of pneumatically-driven pulsa-

Tab. 1 Technical parameters of polish jigs for hard coal beneficiation

Tab. 1 Parametry techniczne polskich osadzarek do wzbogacania węgla kamiennego

Parameter	type	OM	OS	OZ
		8 to 36	**8 to 36**	**8 to 36**
Grain size	mm	30/20 to 0,5	50 to 0,5	120 to 20
Unit capacity	Mg/h	to 25 per 1 m^2 working surface		
Working surface	m^2	8 to 36		
Number of throughs	–	1 or 2		
Number of compartments	–	2-3 or 4-6		
Air pressure	MPa	0,03 to 0,045		
Water consumption	m^3	1,5 to 2,0 per 1 Mg/h of feed		
Power supply	V	230 (computer system) 380/500 (hydraulic compressor)		
Products	–	concentrate, waste (2-products benefication) concentrate, intermediate, waste (3-products benefication)		
Imperfection (average)	–	0,15		
Computer-controlled system	–	1 (trapezoidal water pulsation for OM-type)		

Tab. 2 Technical parameters of polish KOMAG-type jigs for gravel and sand preparation

Tab. 2 Parametry techniczne polskich osadzarek do wzbogacania nadaw żwirowo-piaskowych

Parameter	type	K
		100/150/200
Grain size	mm	32(16) to 2(0)
Unit capacity	Mg/h	to 35 per 1 m^2 working surface
Working surface	m^2	4 to 8
Number of throughs	–	1
Number of compartments	–	1
Air pressure	MPa	0,35 to 0,04
Water consumption	m^3	1,5 to 2,0 per 1 Mg/h of feed
Power supply	V	230 (computer system) 380/500 (hydraulic compressor)
Products	–	gravel, sand, organic and/or mineral impurities
Efficiency (average)	%	90
Sand content in the feed (max)	%	35
Computer-contolled system	–	1 (sinusoidal water pulsation)

tory disc valves, electrohydraulic units for the automatic control of the discharge of heavy product have provided several advantages: control of water pulsation within any selected cycle, automatic control over the discharging of the heavy product and automatic control over the loosening of the bed. The use of these solutions is needed for proper selection of the characteristics of water pulsation cycle to match the specific type of coal or gravel and sand which is cleaned. The article highlights the differences between results received in the jigging process for the normal sinusoidal jigging diagram in single-phase and for two and three-phase rotary or disc valves and describes also new potentials for the application of the jigging technology for gravel and sand preparation to separate mineral and organic impurities from the obtained aggregate.

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Polskie osadzarki wodne pulsacyjne

W artykule przedstawiono informacje o osadzarkach wodnych pulsacyjnych produkowanych w ostatnich latach w Polsce. Pokazano podstawowe parametry techniczne, uzyskiwane przez osadzarki do wzbogacania węgla oraz nadaw żwirowo-piaskowych, odnosząc je do uzyskiwanych wydajności jednostkowych oraz wskaźników jakościowych, takich jak wskaźnik imperfekcji w warunkach pracy zakładu przeróbczego kopalni węgla kamiennego, czy sprawność wydzielania zanieczyszczeń organicznych i/lub mineralnych z nadawy żwirowo-piaskowej w warunkach pracy kopalni kruszyw. Zwrócono uwagę na wysoką skuteczność pracy polskich osadzarek wodnych pulsacyjnych, umożliwiającą zagospodarowanie wszystkich uzyskiwanych w trakcie procesu wzbogacania produktów, w tym produktów kamiennych czy zanieczyszczeń organicznych i/lub mineralnych [3, 5], co jest szczególnie ważne w aspekcie ochrony środowiska naturalnego.

Słowa kluczowe: węgiel kamienny, żwir, piasek, wzbogacanie grawitacyjne, wskaźnik imperfekcji