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The Comparison of Biogas Desulphurisation Process Using Bog Iron Ore and SulfurE – A Case Study

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ABSTRACT

Biogas desulphurisation plants aim to remove hydrogen sulphide and other gaseous compounds that occur in the gas mixture. This mainly concerns the reduction of H_2S which reacts with most metals such as iron or copper, which leads to the corrosion of pipelines and equipment. The aim of this research was to use two materials to adsorb hydrogen sulphide from biogas and to compare the efficiency of these two processes. Biogas was passed through both adsorbents. The concentration of hydrogen sulphide was measured upstream and downstream of the adsorbent bed. The results are summarised in diagrams.The first material used in the biogas desulphurisation plant at the wastewater treatment plant was bog iron ore. The bed was replaced several times during the year to maintain the efficiency of hydrogen sulphide removal from the biogas. After a year, a new adsorbent called "SulfurE" was used in place of the bog iron ore. The new bed operated with higher efficiency than the bog iron ore. The operating period between bed replacements was also extended. The bog iron ore bed in the desulphurisation plant was replaced on average 3 to 4 times a year, depending on the amount of hydrogen sulphide flowing into the desulphurisation plant (the more H_2S, the higher the frequency of bed replacement). The bed in the desulphurisation plant filled with the "SulfurE" product operated for about 9 months with 90% hydrogen sulphide absorption efficiency (depending on the quality of biogas produced).

Keywords: hydrogen sulphide, bog iron ore, Sulfure, desulphurisation, biogas.

INTRODUCTION

The continuous development of civilisation is linked with an increasing demand for energy which is generated from depleting fossil fuels that have an adverse impact on the natural environment. This necessitates the development of alternative methods of obtaining energy, such as renewable energy sources. The renewable energy industry in today's world is undoubtedly a massive support for energy systems in many countries, resulting in reduced environmental pollution, cheap and green energy and innovation in energy systems (Kwaśny et al., 2016)

Biogas is produced by anaerobic digestion process of biodegradable substances. The use of biogas for the production of heat and electricity in cogeneration units necessitates its purification, particularly desulphurisation. The content of hydrogen sulphide (H_2S) in biogas varies and usually ranges from tens to thousands of mg/m^3 and is highly dependent on the type of raw material being digested. The removal of H_2S is necessary, among others, due to corrosive properties of condensates containing sulphur compounds, the need for frequent engine oil changes and environmental pollution by sulphur oxides after biogas combustion (Szymczak et al., 2019 a).

The choice of hydrogen sulphide removal method depends on the initial hydrogen sulphide content, the necessary degree of purification associated with the intended application and the size of the gas stream. As a pre-desulphurisation step, microbiological processes, which do not require large financial outlays, can be used. However, this method does not provide the level of desulphurisation recommended for most biogas applications. In most plants, especially those treating highly sulphated agricultural biogases, combinations of biological and chemical methods - adsorption and absorption - are used (Piskowska-Wasiak, 2014) (Wiącek, 2015).

The removal of hydrogen sulphide from biogas should be carried out by as simple method as possible, preferably in one step, with high process efficiency under normal pressure and temperature conditions. The hydrogen sulphide sorbents should be selected in such a way that they can be used as, for example, a fertiliser after the sorption capacity has been exhausted (Szymczak, 2019b) (Płacheta, 2019).

The main solid sorbents containing iron and used for biogas desulphurisation are natural and modified bog iron ores, artificially synthesised hydrated iron oxides, iron (III) hydroxide, halloysite sorbent and certain granulated desulphurisation materials (Kamiński, 2024) (Żarczyński et al., 2015) (Kwaśny et al., 2016) (Szymczak et al., 2019 b).

Due to its dynamic development and high investment outlays, biogas production and its widespread use is becoming an alternative to fossil fuels. In order to use biogas effectively, it needs to be purified from hydrogen sulphide which is a typical component of biogas. Hydrogen sulphide not only causes atmospheric pollution, but also has an adverse effect on the cogeneration equipment used to produce electricity and heat from biogas. The presence of H_2S causes process disruption and accelerates corrosion of equipment. The removal of H_2S from biogas before further use is therefore necessary for technical and environmental reasons (Żarczyński et al., 2015).

Biogas desulphurisation plants aim to remove hydrogen sulphide and other gaseous compounds present in the mixture. This mainly concerns the reduction of H_2S which reacts with most metals such as iron or copper, which leads to the corrosion of pipelines and equipment. Hydrogen sulphide is converted to sulphur dioxide (SO_2) and sulphuric acid (H_2SO_4). Both of these compounds have highly corrosive properties (Kwaśny et al., 2016).

Among the methods for hydrogen sulphide removal, there are methods such as biological oxidation, the adsorption technique, the use of bog iron ore beds and so-called wet methods (Kwaśny et al., 2016). The use of the bog iron ore method involves the adsorption of hydrogen sulphide on alkaline iron oxides by passing the biogas through a bed located in the desulphurisation plant. The products of this reaction are sulphur and iron (II) and (III) sulphide. In the case of bog iron ore, the bed can be regenerated by passing air through it with the addition of steam (Kwaśny et al., 2016).

The most common method for hydrogen sulphide removal is biological oxidation which involves pumping air into the biogas. The next step is to use an active biological layer and pass the air-biogas mixture through it. Due to the action of bacteria, sulphates and sulphur are obtained. The efficiency of H_2S removal is in the range of 80–99%. The low investment and operating costs speak in favour of choosing this method. No chemicals used in the system and the maintenance-free operation of the process are also advantageous (Kwaśny et al., 2016) (Kaminski, 2024).

The next method of biogas desulphurisation is the use of adsorption techniques which show hydrogen sulphide removal efficiency at a level of 99%. This technology is most cost-effective at low H_2S concentrations. The adsorbent used in this method is a carbon, mineral or mineral-carbon adsorbent which is placed in a filter column through which the gas is passed. Activated carbon can be reused and recovered several times, which reduces costs while maintaining high hydrogen sulphide removal efficiency (Kwaśny et al., 2016) (Kamiński, 2024).

Another method of biogas desulphurisation is the wet method which involves the sorption of hydrogen sulphide with chemical solutions that can bind H_2S. In scrubbing towers, hydrogen sulphide is removed from the biogas with the use of a liquid. High costs of regenerating the liquid and high consumption of chemical solutions rank these methods as unprofitable. The choice of biogas desulphurisation methods depends mainly on the hydrogen sulphide content in the biogas (Kwaśny et al., 2016) (Kaminski, 2024).

This paper presents a study of biogas desulfurization using two adsorbents: turf ore and the commercial product "SulfurE". Biogas was passed through these materials after which the efficiency of these processes was compared. The novelty of the research is the analysis of the efficiency of hydrogen sulfide removal from biogas using the new material "SulfurE" and comparing it with the known natural product turf ore.

MATERIAL AND METHODS

Biogas desulphurisation plant in Tychy

The biogas desulphurisation plant located at the wastewater treatment plant in Tychy is a facility used for the removal of hydrogen sulphide from biogas. The continuous development of the treatment plant translating into an increase in biogas production capacity led to the expansion of the desulphurisation plant in 2011. This investment involved enlarging the reinforced concrete chamber and adding two more adsorbers. After the expansion, the desulphurisation plant consisted of a total of four adsorbers. Adsorbers are steel tanks in the shape of a cuboids which consist of two parts and a body that can accommodate three beds. The bodies are positioned on a plastic grate and are fitted with closing lids to prevent rainwater from entering. Adsorbers are connected to the system via biogas inlet and outlet ports. All adsorbers are connected by pipe fittings with gate valves and a built-in biogas meter. The chamber with the adsorbers is located below ground. In this way, the biogas pipelines do not have to be routed above ground, but rather in the ground all the time.

The form of construction of the desulphurisation plant (Figure 1) allows the bed to be replaced without stopping the continuous flow of biogas from H_2S. The gate valves used allow the flow of biogas through the bed to be cut off and the bed to be replaced freely. When replacing the bed, there is no risk of hydrogen sulphide being emitted into the atmosphere and there is no toxic or explosion hazard. Each time the adsorber lid is opened to replace the bed, a tightness test is performed to confirm the correct operation of the unit. After a positive result of such a tightness test, the adsorber is reconnected for further operation in the desulphurisation process.

The aim of the research was to use two materials that adsorb hydrogen sulphide from biogas and to compare the efficiency of the two processes. Biogas was passed through both adsorbents. The concentration of hydrogen sulphide was measured upstream and downstream of the adsorbent bed. The results are summarised in diagrams. A portable biogas analyzer was used to analyze the biogas composition.

Characteristic of applied material

The first material used in the biogas desulphurisation plant at the wastewater treatment plant in question was bog iron ore. This product has a high content of iron compounds which have hydrogen sulphide-binding properties (Table 1). Bog iron ore can be used for desulphurisation of both landfill biogas, synthesis gas and coke-oven gas. Thanks to its optimised density and high porosity of the material, it provides extremely high hydrogen sulphide-binding efficiency with

Table 1. Information on the main components of bog iron ore (Kania, 2020a)

Iron compounds	35.00–48.50% by weight
SiO_2	7.88–14.70
TiO_2	0.01–0.02
Al_2O_3	0.01–0.28
CaO	1.74–2.63
MgO	0.01–0.08
MnO	0.08–0.22
K_2O	0.01–0.07
Na_2O	0.01–0.04
P_2O_5	2.51–3.11

Figure 1. Biogas desulphurisation plant at the wastewater treatment plant in Tychy

low flow resistance. Ensuring high efficiency of H_2S binding process depends on relative humidity, which should be approximately 100%, and a temperature of 20 °C to 60 °C. Bog iron ore, after being used in the desulphurisation plant, is treated as waste which is not classified as hazardous waste. In the waste catalogue, it is classified as wastes from waste management facilities, off-site waste water treatment plants and the preparation of drinking water and water for industrial use. It can be landfilled or used for land reclamation. According to the supplier's technical data sheet, its waste code is 19 08 99 or 06 06 03 (Kania, 2020a).

The second product used for biogas desulphurisation at the wastewater treatment plant is "SulfurE" granulate (Table 2) which also has a high content of iron compounds. This provides it with the ability to bind hydrogen sulphide. Similarly as with bog iron ore, it is used to eliminate hydrogen sulphide from landfill biogas, synthetic and coke-oven gases and biogases in municipal and agricultural wastewater treatment plants. The high H_2S binding efficiency results from the correct proportion and size of the granules and the porosity of the material from which they are made. In pursuit of the most efficient hydrogen sulphide binding process, the biogas must have a relative humidity of approximately 100% and its temperature should be in the range of 20 to 60 °C. The granulate in the desulphurisation plant fulfils its application depending on the type of biogas, its composition, quantity, flow rate and the design of desulphurisation equipment. After the application of "SulfurE", the bed is in an initial "adjustment" phase, during which an increase in the temperature of the biogas downstream of the desulphurisation plant and an increased methane content can be observed. After being used, "SulfurE" is treated as non-hazardous waste. It can be destined for landfill or used for land reclamation. Its waste code is 19 08 99 or 06 06 03 (Kania 2020b).

RESULTS AND ANALYSIS

The measurements taken upstream and downstream of the biogas desulphurisation process using two different adsorbent beds, bog iron ore and "SulfurE", allowed a comparison between the two adsorbents in terms of biogas desulphurisation efficiency and made it possible to determine the period of time after which the sorbent should be replaced with a new one. Data on the amount of hydrogen sulphide were obtained on average once a week by a biogas analyser and automatically uploaded to the system. The results of these measurements are summarised in Figures 2 to 4.

When analysing the diagram shown in Figure 2, it can be seen that the highest value of hydrogen sulphide concentration measured upstream of the desulphurisation plant occurred on 5 September and was 2.596 g/dm^3. The lowest value recorded occurred on 14 February and was 43 g/dm^3. The average value from the hydrogen sulphide measurements obtained was 478 g/dm^3. In 2018, the bog iron ore bed was replaced 6 times due to inefficient hydrogen sulphide removal from the biogas. If we look at the values obtained downstream of the desulphurisation plant, we can notice that the reduction in the amount of hydrogen sulphide varied significantly. The highest recorded value of hydrogen sulphide in the biogas after desulphurisation occurred on 2 September and was 1267 g/dm^3, while the lowest value obtained was 8 g/dm^3. The average amount of hydrogen sulphide obtained downstream of the desulphurisation plant was 180 g/dm^3.

From the diagram in Figure 2, it can be seen that until the end of March the amount of hydrogen sulphide upstream of the desulphurisation plant was in the range of up to 500 g/dm^3. Subsequently, it can be seen that there was an increase in the amount of hydrogen sulphide in the biogas at the beginning of April and the bog iron ore was replaced also during that time. This translated into a decrease in the amount of hydrogen sulphide in

Table 2. Information on the main parameters of "SulfurE" (Kania 2020b)

Colour	Clay-brick
Diameter [mm]	4.5–5.5
Length [mm]	5.0–15.0
Bulk density [kg/m^3]	700–800
Iron compound content [%]	30–40
Maximum amount of sulphur compounds absorbed by the bed unit [%]	40

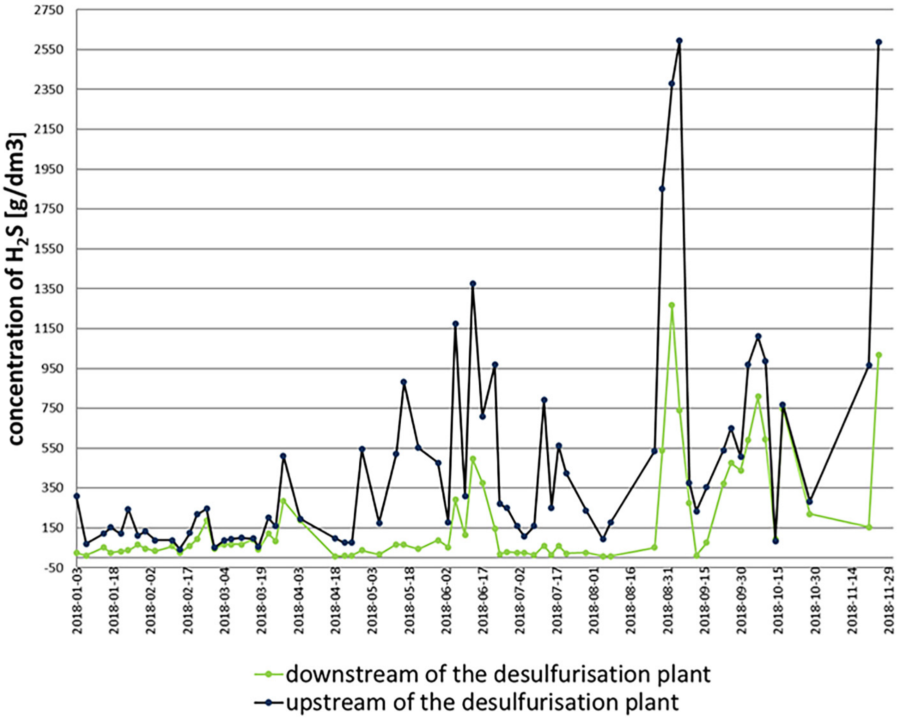

Figure 2. Changes in hydrogen sulphide concentrations upstream and downstream of bog iron ore in 2018

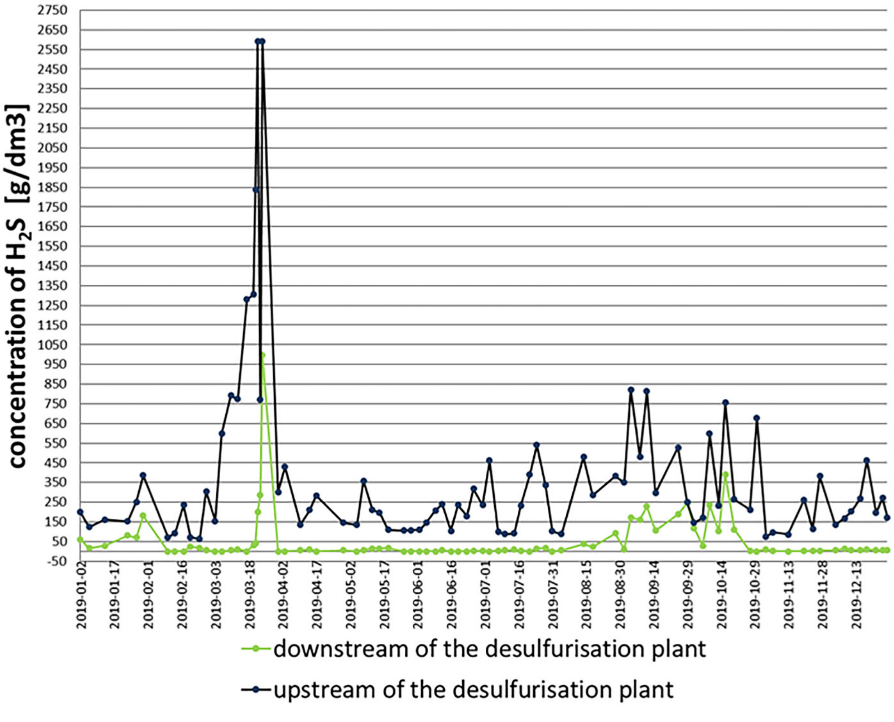

Figure 3. Changes in hydrogen sulphide concentrations upstream and downstream of the "SulfurE" adsorbent in 2019

the biogas downstream of the desulphurisation plant. Another bed replacement took place after 17 June, as a large decrease in H_2S concentrations in the biogas downstream of the desulphurisation plant can be seen in the next measurement. Large fluctuations in the concentration values also occurred in August, indicating another bed replacement and a decrease in hydrogen sulphide after desulphurisation. It can be deduced that, depending on the amount of hydrogen sulphide flowing

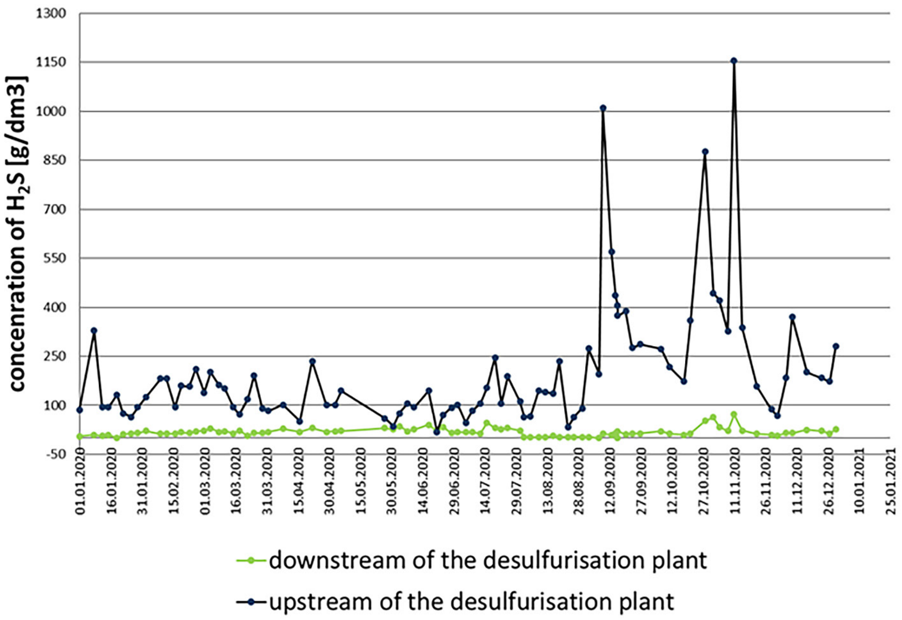

Figure 4. Changes in hydrogen sulphide concentrations upstream and downstream of the "SulfurE" adsorbent in 2020

into the desulphurisation plant, the bog iron ore bed removed harmful hydrogen sulphide from the biogas with an efficiency of 61% on average. During the occurrence of high concentrations of hydrogen sulphide upstream of the desulphurisation plant, the efficiency of desulphurisation with bog iron ore was 53% on average.

In 2019, "SulfurE" was used for the first time in the desulphurisation plant as a hydrogen sulphide absorption bed. This event took place on 10 February. When analysing the diagram shown in Figure 3, it can be seen that this granulate has much better adsorbing properties than bog iron ore, which translated into much better results in removing hydrogen sulphide from the biogas.

The highest measured value of hydrogen sulphide concentration upstream of the desulphurisation plant was observed on 24 March and it was 2.593 g/dm^3 and after it flew through the desulphurisation plant, a concentration of 999 g/dm^3 was achieved. This translates into an H_2S removal efficiency of approximately 62%. In comparison, on 22 March, the amount of hydrogen sulphide upstream of the desulphurisation plant was 2.592 g/dm^3 and its value downstream of the desulphurisation plant was only 202 g/dm^3, which translated into a bed efficiency of approximately 92%. For the rest of the year, we can read from the available results that the bed operated with almost 100% efficiency removing hydrogen sulphide. The replacement of the bed took place on 5 October after 8 months from the first filling of the desulphurisation plant with "SulfurE". In 2019, the bed in the desulphurisation plant was replaced twice, reducing the cost of bed replacement and affecting the efficiency of hydrogen sulphide removal from biogas compared to bog iron ore. The average efficiency of the desulphurisation process was approximately 88% in 2019.

In 2020, biogas desulphurisation with "SulfurE" was continued. Taking into account the dynamics of changes in hydrogen sulphide concentrations upstream and downstream of the "SulfurE" adsorbent, it can be concluded that this bed removed hydrogen sulphide at an average of 94%. After analysing the hydrogen sulphide removal results achieved in 2019 and 2020, "SulfurE" was found to have better hydrogen sulphide binding capacity than bog iron ore. This also translated into a lower frequency of bed replacement in the desulphurisation plant, which reduced the operating costs of the desulphurisation plant. Another positive aspect of the lower frequency of bed replacement undoubtedly turned out to be the better organisation of work of the technical department. The staff spent much less time organising the work associated with bed replacement, so they could devote it to other tasks.

The next step in the analysis of the results obtained was to compare the average amount of hydrogen sulphide removed upstream and downstream of the desulphurisation plant with the average biogas production in a given month. After multiplying the average values of the amount of hydrogen sulphide removed by the average biogas production, the average amount of hydrogen sulphide present in the biogas flowing into the desulphurisation plant and downstream of the desulphurisation plant was obtained. After subtracting these two values, the average amount of hydrogen sulphide removed by the bed was obtained. The results are presented in Tables 3 to 5.

In 2018, an average of 111.33 kg/d of hydrogen sulphide was removed from the biogas. The highest value was obtained in November 32.14 kg/d and the lowest value was obtained in February 1.39 kg/d. The highest average value of hydrogen sulphide upstream of the desulphurisation plant was recorded in November and it was 32.75 kg/d and the lowest value in March and it was 2.12 kg/d. When analysing the results obtained downstream of the desulphurisation plant, the highest value was obtained in February 0.84 kg/d, while the lowest value was obtained in March 0.03 kg/d. The best H_2S parameters were achieved in the first 4 months of 2018, but this was directly related to the relatively good parameters of the biogas even before the desulphurisation process.

Table 3. Summary of average amounts of hydrogen sulphide removed by month in 2018

Month	Average H_2S concentration upstream of the desulphurisation plant (mg/m^3)	Average H_2S concentration downstream of the desulphurisation plant (mg/m^3)	Average biogas production (m^3/d)	Average amount of H_2S upstream of the desulphurisation plant (kg/d)	Average amount of H_2S downstream of the desulphurisation plant (kg/d)	Average amount of H_2S removed (kg/d)
January	157.75	23.75	16.337	2.58	0.39	2.19
February	122.68	46.43	18.188	2.23	0.84	1.39
March	163.13	67.25	12.981	2.12	0.03	2.09
April	198.22	32.6	15.908	3.15	0.05	3.1
May	521.41	36.8	20.990	10.94	0.23	10.71
June	654.65	124	22.701	14.86	0.34	14.52
July	336.46	20.13	18.707	6.29	0.12	6.18
August	664.46	98.25	15.964	10.61	0.17	10.44
September	954.37	296.88	17.430	16.63	0.29	16.63
October	700.76	330.67	17.328	12.14	0.21	11.93
November	1,776.01	380.5	18.438	32.75	0.6	32.14

Note: *kg/d – kilograms per day

Table 4. Summary of average amounts of hydrogen sulphide removed by month in 2019

Month	Average H_2S concentration upstream of the desulphurisation plant (mg/m^3)	Average H_2S concentration downstream of the desulphurisation plant (mg/m^3)	Average biogas production (m^3/d)	Average amount of H_2S upstream of the desulphurisation plant (kg/d)	Average amount of H_2S downstream of the desulphurisation plant (kg/d)	Average amount of H_2S removed (kg/d)
January	138.17	73.36	17.427	2.41	1.28	1.13
February	90.83	7.95	16.638	1.51	0.13	1.38
March	768	143.41	21.027	16.15	3.02	13.13
April	156.6	4.31	19.239	3.01	0.08	2.93
May	113.43	7.48	18.310	2.08	0.14	1.94
June	128.22	1.2	18.319	2.35	0.02	2.33
July	168.89	5.81	16.686	2.82	0.1	2.72
August	201	39.63	17.183	3.45	0.68	2.77
September	328.29	158.96	18.938	6.22	3.01	3.21
October	248.75	123.5	17.137	4.26	2.12	2.15
November	109.83	3.33	17.439	1.92	0.06	1.86
December	152.5	7.31	18.449	2.81	0.13	2.68

Table 5. Summary of average amounts of hydrogen sulphide removed by month in 2020

Month	Average H_2S concentration upstream of the desulphurisation plant (mg/m³)	Average H_2S concentration downstream of the desulphurisation plant (mg/m³)	Average biogas production (m³/d)	Average amount of H_2S upstream of the desulphurisation plant (kg/d)	Average amount of H_2S downstream of the desulphurisation plant (kg/d)	Average amount of H_2S removed (kg/d)
January	120.81	8.66	19.152	2.31	0.17	2.15
February	158.52	15.83	20.280	3.21	0.32	2.89
March	135.6	18.13	17.983	2.44	0.33	2.11
April	114.19	22.78	15.200	1.74	0.35	1.39
May	85.41	24.62	14.849	1.27	0.37	0.9
June	85.74	27.48	15.879	1.36	0.44	0.93
July	126.71	24.8	16.104	2.04	0.4	1.64
August	108.24	3.25	15.789	1.71	0.05	1.66
September	421.53	9.39	17.801	7.5	0.17	7.34
October	379.21	21.55	18.503	7.02	0.4	6.62
November	418.39	33.64	16.271	6.81	0.55	6.26
December	208.42	17.81	15.847	3.3	0.28	3.02

Figures 5 to 7 summarise the average monthly amounts of hydrogen sulphide removed between 2018 and 2020. It can be deduced from Figure 5 that the amount of hydrogen sulphide upstream of the desulphurisation plant increased as the average biogas production increased in a given month. The highest values for hydrogen sulphide concentrations occurred in the second half of 2018, with bed replacement occurring in March then June and November. In 2019, an average of 38.23 kg/d of hydrogen sulphide was removed. Taking into account the period of operation of one bed (the period from replacement to replacement of the bed in the desulphurisation plant), a result of 32.56 kg H_2S was achieved. In February 2019, the "SulfurE" adsorbent was used in the desulphurisation plant for the first time. The next bed replacement took place in October, after 10 months of operation. As can be seen in Figure 6, the highest concentration upstream of the desulphurisation plant was in March, when the bed was adapting to absorb hydrogen sulphide. After replacing the bed,

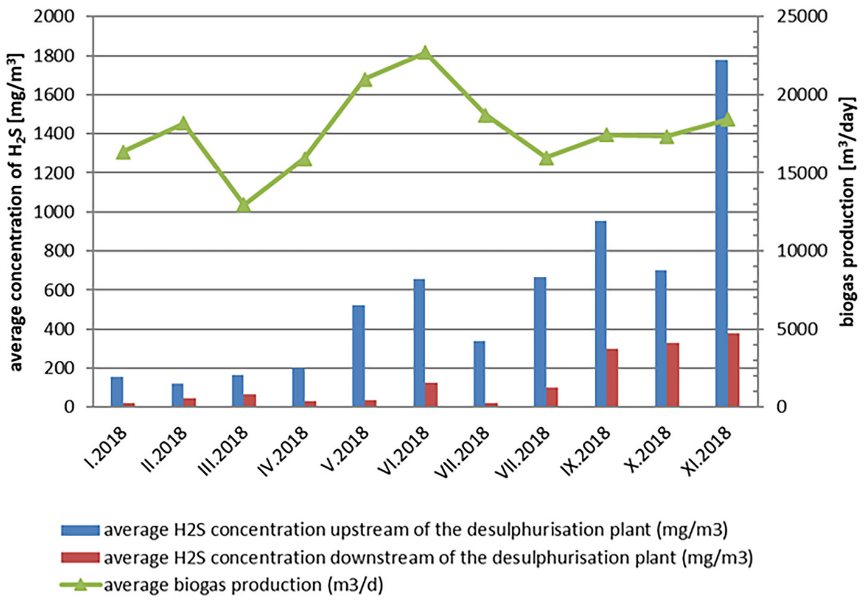

Figure 5. Summary of monthly average concentrations of hydrogen sulphide removed with bog iron ore in 2018

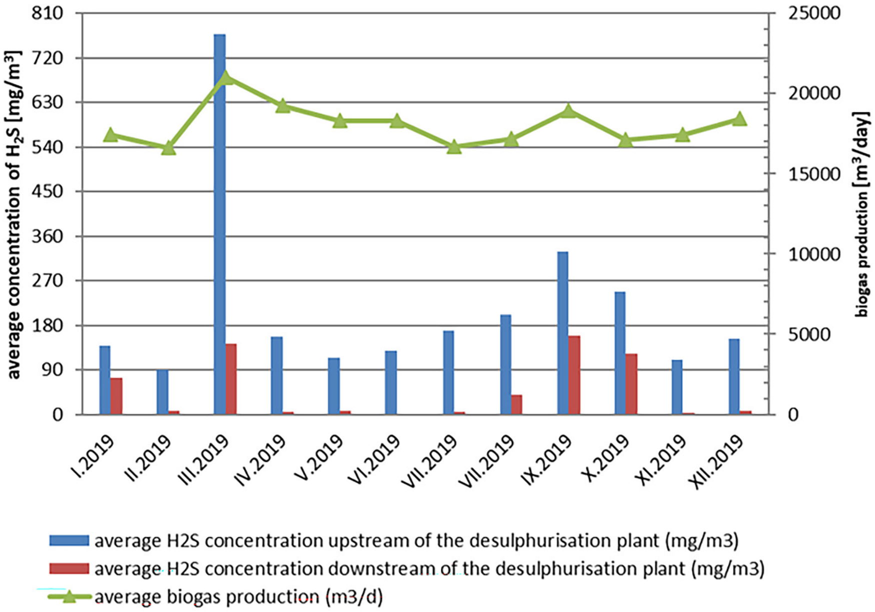

Figure 6. Summary of monthly average concentrations of hydrogen sulphide removed with the “SulfurE” adsorbent in 2019

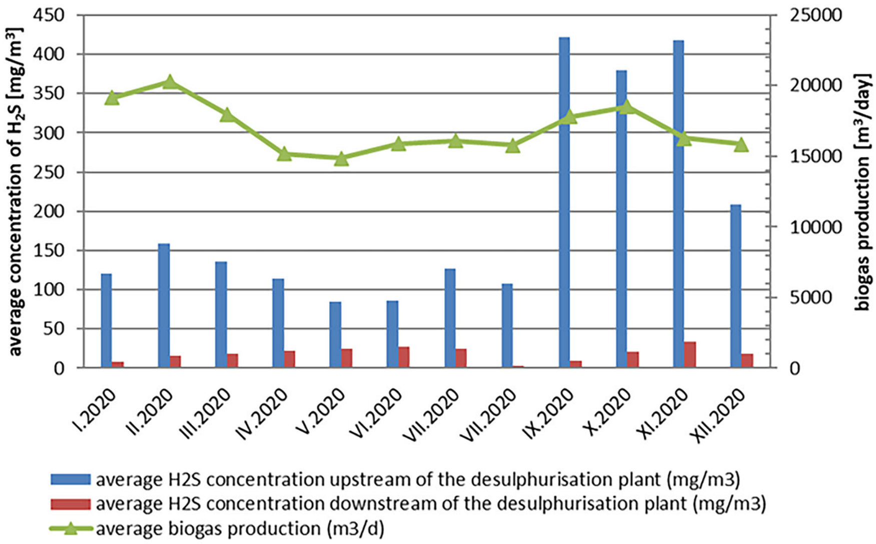

Figure 7. Summary of monthly average concentrations of hydrogen sulphide removed with the “SulfurE” adsorbent in 2020

the “SulfurE” sorbent was absorbing H_2S almost completely. A minimal increase in concentration downstream of the desulphurisation plant in August and September is noticeable. In October, the bed was replaced, which had a positive effect in November and December. Biogas production did not affect the hydrogen sulphide values upstream and downstream of the desulphurisation plant as much as in the case of bog iron ore, where the increase in biogas production translated into an increase in concentration both upstream and downstream of the desulphurisation plant.

Following the positive evaluation of the replacement of the bog iron ore bed with “SulfurE”, the desulphurisation plant continued operation with the new adsorbent in 2020. Looking at the results obtained, it can be concluded that the bed started to operate much better after the first replacement, which is reflected in better results achieved downstream of the desulphurisation plant. Taking into account similar loading of both beds, it can be concluded that the “SulfurE” adsorbent has better hydrogen sulphide absorption properties than bog iron ore. The tested bed also shows longer operation without replacing the bed with a new one, and thus longer H_2S capture efficiency. This results in a longer operating time of this bed compared to bog iron ore.

It can be deduced from Figure 7 that for the first 8 months of 2020, the hydrogen sulphide concentrations upstream of the desulphurisation plant followed the same pattern as the average biogas production. The lower the average biogas production, the less H_2S there was upstream of the desulphurisation plant, and the more biogas there was, the more hydrogen sulphide there was upstream of the desulphurisation plant. The exceptions are the last 4 months, where there was relatively more hydrogen sulphide upstream of the desulphurisation plant. It can be seen that downstream of the desulphurisation plant, the amount of hydrogen sulphide was at a similarly low level as in the earlier months. Thus, regardless of the amount of hydrogen sulphide upstream of the desulphurisation plant, after passing through the bed with the "SulfurE" adsorbent, the efficiency of desulphurisation was still at a high level.

Cybulska et al. (2008) conducted studies on the effectiveness of removing hydrogen sulfide from biogas using a desulfurisation mass formed from turf ore. It was found that the treatment of biogas using the studied desulfurization mass makes it possible to reduce the concentration of H2S below the technically required value of 200 mg/m^3. The results confirmed that under the conditions of the studied treatment plant, it is sufficient to replace the bed every six months. In the biogas purification technology considered by Gaj and Cybulska-Szulc (2008), the total bed depletion time calculated by the developed model is 439 days, while the practical life of the bed (i.e., until 20% efficiency is achieved) is 235 days.

However, since biogas desulfurisation studies are conducted on a technical scale, it is difficult to find two cases that are the same and can be compared with each other. In addition, there are very few publications in the literature on the effectiveness of biogas desulfurization using turf ore and the commercial product „SulfurE".

CONCLUSIONS

The aim of the study was to use two materials that adsorb hydrogen sulfide from biogas and compare the effectiveness of the two processes. Turf ore and the commercial product SulfurE were used. Biogas was passed through both adsorbents. Before and after the adsorbent bed, the concentration of hydrogen sulfide was measured using a portable analyzer. Analysis of the results led to the following conclusions:

1. "SulfurE" has better H_2S absorption capabilities than bog iron ore.
2. On average, the bog iron ore bed in the desulphurisation plant was replaced three to four times a year, depending on the amount of hydrogen sulphide flowing into the desulphurisation plant.
3. The bed in the desulphurisation plant filled with "SulfurE" operated for about nine months with a hydrogen sulphide absorption efficiency of 90%.
4. Depending on the amount of hydrogen sulphide flowing into the desulphurisation plant, the bed with bog iron ore removed hydrogen sulphide from the biogas with an average efficiency of 61%, while the bed with the "Sulfur E" sorbent with an average efficiency of 88–94%.

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