ARCHIVES
of
FOUNDRY ENGINEERING

ISSN (2299-2944)
Volume 2026
Issue 1/2026

157 – 164

19/1

10.24425/afe.2026.157982

Published quarterly as the organ of the Foundry Commission of the Polish Academy of Sciences

Casting Production in Poland and Worldwide during the Past 60 Years

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Received 27.09.2025; accepted in revised form 23.12.2025; available online 30.03.2026

Abstract

In the article, changes in the total volume of casting production over the past 60 years are discussed, both on a global scale and in Poland. It was found, among others, that while in Poland the maximum volume of this type of production, at the level of approximately 2.5 million tons, occurred in the mid-1970s, in the case of global production the maximum output (about 120 million tons) was recorded in 2023. The study compares the shares of different types of cast iron and steel castings in the total production of ferrous alloy castings, both worldwide and in Poland, during the considered period of approximately 60 years. It was found, among others, that spheroidal graphite cast iron has been gaining increasing interest as a foundry material, whereas in the production of ferrous alloy castings, the share of grey cast iron and steel castings has been decreasing. Among non-ferrous metals, aluminium alloys have been clearly gaining in importance. Based on the collected data, it was observed that casting production, particularly in the last 20 years, has "shifted" from Europe and the USA to Asian countries, mainly China and India. The article characterises in more detail the changes in the volume of casting production from the basic foundry alloys, both on a global scale and in Poland, as well as in several selected countries belonging to the group of leaders. It was found, among others, that while currently the largest casting production is characteristic of the Chinese industry, the highest average annual growth rate of ferrous alloy casting production in the years 2001–2023 was recorded by the Indian industry. In the past period of over 20 years in Poland, the fastest growth was observed in the production of aluminium alloy castings.

Keywords: Foundry production, Grey cast iron, Spheroidal graphite cast iron, Steel castings, Aluminium alloys

1. Introduction

Sixty years is, on the one hand, a relatively long period of time, but on the other hand, it constitutes only about one percent of the history of foundry engineering [1]. It is significant that even the beginnings of this period can still be recalled by some of the older readers. Therefore, it seems purposeful to present the changes in casting production, both in Poland and worldwide, considering precisely this period.

It is worth recalling that fifty to sixty years ago the approaching end of the "iron era" was predicted, mainly due to the development of the plastics industry and the anticipated elimination of metal products or at least the reduction of their importance. Today, it is already clear that such forecasts have proved completely erroneous.

The presentation of changes in casting production is worth preceding with data on the changes in crude steel production in Poland and worldwide during the period under consideration. Table 1 presents the crude steel production volumes in Poland and worldwide in several selected years of the past 60 years.

Steel production in Poland reached its maximum level in 1980, amounting to nearly 20 million tons. In the subsequent period, this production clearly decreased, and in 2024 it amounted to only about 7 million tons.

Table 1.
Crude steel production in Poland and worldwide in selected years (1966–2024).

	Crude steel production (million tonnes)					
	1966	1971	1980	2004	2013	2024
Poland	9.9*	12.6	19.5	6.4	7.9	7.1
World	472.7	582.5	717.4	1069.2	1650.3	1884.6

* Data for crude steel production in Poland in 1966 are taken from [2]; all remaining data are from [3].

In the case of crude steel production on a global scale, one can speak of approximately a fourfold increase in production volume in the years 1966–2024; it is worth emphasizing here that the "threshold" of producing one billion tons of crude steel within one year was exceeded twenty years ago.

An important supplement to the information presented later, concerning casting production in Poland, may be data referring to casting production in the years preceding World War II. The total casting production amounted to about 180 thousand tons in 1936 and about 232 thousand tons in 1937 [4]. The quantities of castings produced in those years from cast iron, steel, and non-ferrous alloys were approximately 160 thousand tons, more than 15 thousand tons, and nearly 5 thousand tons, respectively, in 1936, and 205 thousand tons, more than 21 thousand tons, and more than 5 thousand tons, respectively, in 1937 [4].

2. Outline of Changes in Casting Production in Poland and Worldwide

In a few studies, e.g. [5–10], the data concerning casting production volumes, its structure, and a range of other information were based mainly on compilations published in Modern Casting. In the recent period, however, the editorial board of this journal has ceased publishing the relevant compilations prepared based on data supplied by individual countries. Moreover, complete data on worldwide casting production are also lacking in the World Foundry Organization Report for the year 2024 [11]. This report includes only the data provided by the five largest casting producers in the world (China, India, Japan, Germany, and the USA) and by 15 other countries, including Poland.

The total casting production worldwide in the years 1966–2023 and in Poland in the years 1965–2023 is presented in Figures 1 and 2. Worldwide casting production (see Fig. 1), during the first 15 years of the period under discussion, ranged between 70 and 90 million tons annually. After a gradual decline in production volumes in the years 1980–1983, to slightly above 30 million tons of castings per year, casting production began to exhibit an upward trend. This trend has essentially continued to the present day, although it was not without downturns in the years 2008–2009 and 2020–2021, caused respectively by the economic crisis and the COVID-19 pandemic.

Differently from worldwide casting production, the situation developed in Poland in the years 1965–2023 (see Fig. 2). Until 1977, production increased rapidly, reaching a maximum level of 2,652.2 thousand tons. At that time, this represented slightly more than 3% of global casting production [10].

The subsequent period, of about 15 years, was characterized by a downward trend. In the years 1992–2005, the total annual casting production ranged between 0.6 and 0.8 million tons. In the following years, a moderate upward trend appeared. Annual production increased to about 1 million tons; in 2013, it was even considerably higher. Similarly to worldwide production, in the case of Poland the economic crisis and the COVID-19 pandemic also had a negative impact on casting output. In the last two years covered by the analysis (2022 and 2023), about 0.75 million tons of castings from all types of foundry alloys were produced annually in Poland.

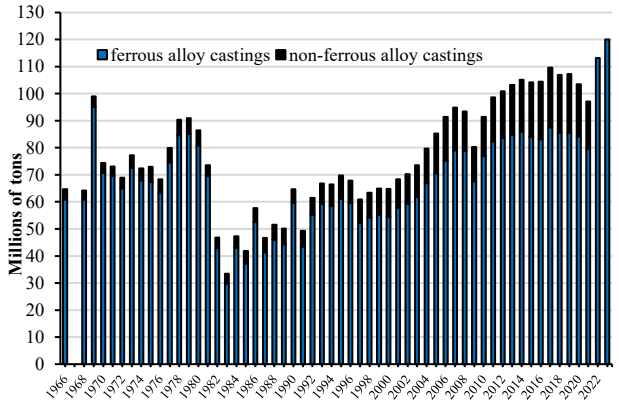

Fig. 1. Total casting production worldwide in the years 1966–2023 [12–66]. For the period 1966–2021, the division into castings from ferrous alloys and non-ferrous alloys was considered. Where data were lacking, empty fields were left. For the years 2022 and 2023, only the total casting production is given due to the absence of detailed data

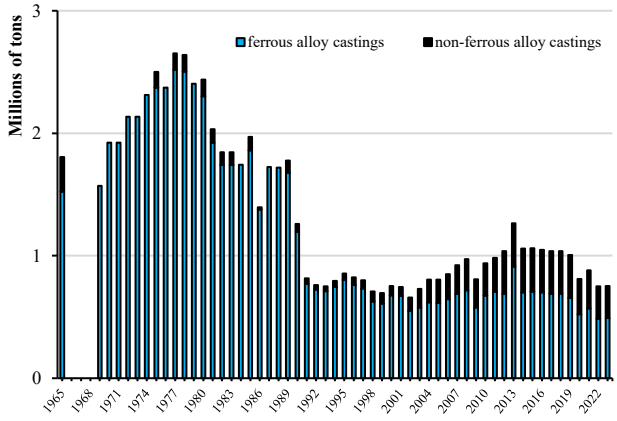

Fig. 2. Total casting production in Poland in the years 1965–2023, including the division into castings from ferrous alloys and non-ferrous alloys [12–18, 21, 24, 26, 27, 30–66]. Where data were lacking, empty fields were left. For the years 1965, 1975, 1977, 1978, 1980–1983, and 1985, the data were taken from [4]. For the years 1969–1974, 1976, 1979, 1984, 1987, and 1988, only the total casting production is given due to the absence of detailed data

The data presented in Figures 3 and 4 allow, respectively, a comparison of the shares of different types of cast iron and steel castings in the total production of ferrous alloy castings, with reference to worldwide casting production in the years 1966–2021 and to production in Poland in the years 1965–2023.

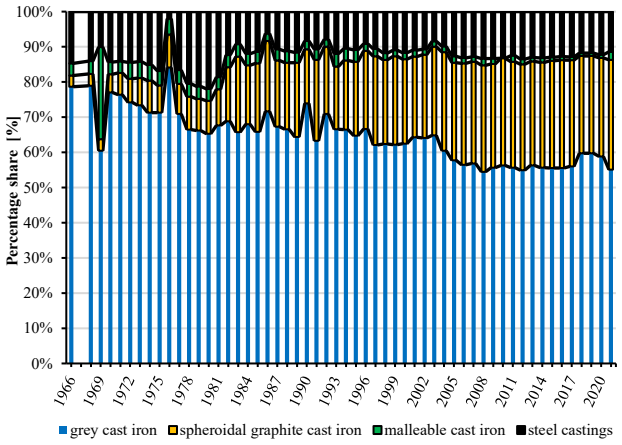

Fig. 3. Comparison of the shares of different types of cast iron and steel castings in the total production of ferrous alloy castings worldwide in the years 1966–2021 [12–64]

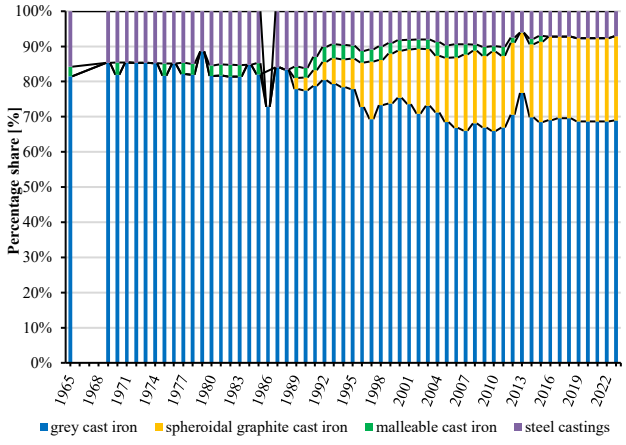

Fig. 4. Comparison of the shares of different types of cast iron and steel castings in the total production of ferrous alloy castings in Poland. For the years 1971–1974, 1976, 1979, and 1986–1988, no detailed data are available regarding the production volumes of spheroidal graphite and malleable cast iron [12–66]

The data presented in Figures 3 and 4 show that over the past approximately 60 years malleable cast iron has been attracting decreasing interest as a material for castings. In the case of Poland, its share in the total casting production is virtually symbolic; the share of steel castings in the total casting production has also decreased over the past 50 years. Thus, while on a global scale this share exceeded 20% in the second half of the 1970s, in the last few years it has already been at the level of 12–14%. For analogous periods, the share of steel castings in Polish production decreased from about 13% to about 7%.

The material that in recent decades has gained and continues to gain in importance is spheroidal graphite cast iron. On a global scale, its share in ferrous alloys as a material for castings in the last years covered by the analysis amounted to about 30%. In the case of Polish foundry production, spheroidal graphite cast iron accounted in 2023 for about 24% of all ferrous alloy castings (in terms of their mass).

Concluding the discussion on the use of different types of cast iron and steel castings (within the group of ferrous alloys), it should be noted that on a global scale the share of grey cast iron decreased in the analysed period from about 70–80% to about 55%, while in the case of Poland the corresponding share decreased from slightly above 80% to nearly 70%.

The data presented in Figures 5 and 6 allow a comparison of the shares of Al, Cu, Mg, Zn alloys and other metals in the total production of non-ferrous alloy castings in the years 1966–2021, with reference to worldwide production and to production in Poland, respectively.

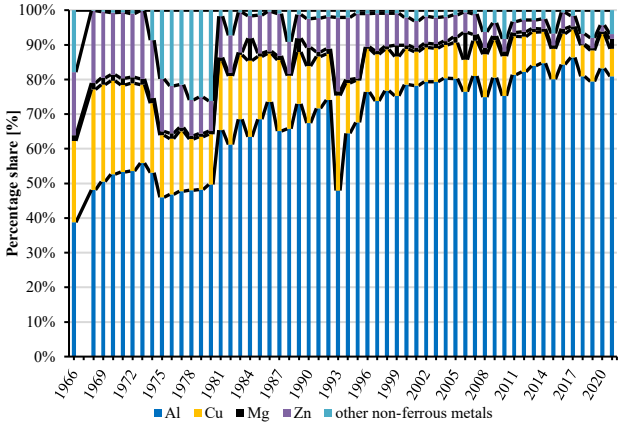

Fig. 5. Comparison of the shares of Al, Cu, Mg, Zn alloys and other metals in the total production of non-ferrous alloy castings worldwide in the years 1966–2021 [12–64]

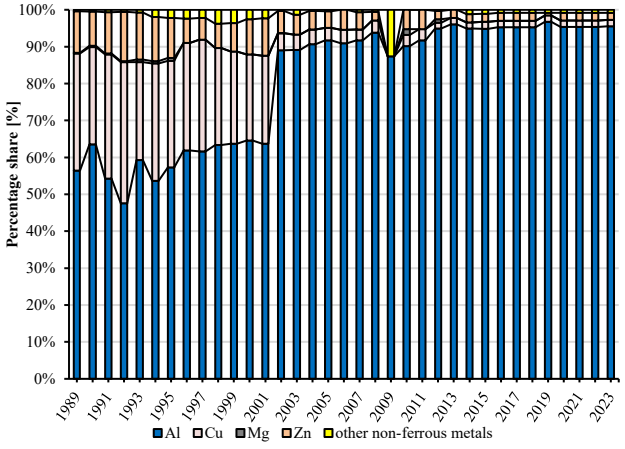

Fig. 6. Comparison of the shares of Al, Cu, Mg, Zn alloys and other metals in the total production of non-ferrous alloy castings in Poland in the years 1989–2023 [33–66]. No data are available for the earlier period

The data presented in Figure 5 indicate that over the past nearly 60 years the share of aluminium alloys in the total production of non-ferrous alloy castings has increased. While in the 1960s and 1970s this share amounted to about 50%, in the last years covered by the analysis it reached about 80%. The share of copper alloys decreased—from about 30% in the years 1968–1972 to about 8–10% in the years 2000–2021—as did the share of zinc alloys.

In the case of Polish foundry production (see the data in Fig. 6), the share of aluminium alloys in the total production of non-ferrous alloy castings was about 50–60% in the last decade of the 20th century (with no earlier data available), followed by an almost abrupt increase—from slightly above 60% in 2001 to about 90% in 2002. This indicator has remained at a high level, currently exceeding 90%. The share of copper alloys in the production of non-ferrous alloy castings decreased from about 35% in 1992 to slightly above 10% in 2002 and has shown a downward trend.

In the period covered by the analysis (1989–2023), the share of zinc alloys in the total production of non-ferrous alloy castings has also shown a decreasing trend. Concluding the presentation of the results concerning the production volumes of non-ferrous alloy castings, it should be noted that the leading role of aluminium in this field in the years 2000–2019 was discussed, among others, in [67].

3. Casting Production in the 21st Century

More attention should be devoted to casting production in the 21st century. Figure 7 compares the structure of global casting production in the years 2000 and 2021, taking into account the continents. The comparison of the data demonstrates the currently dominant role of Asian countries in worldwide casting production.

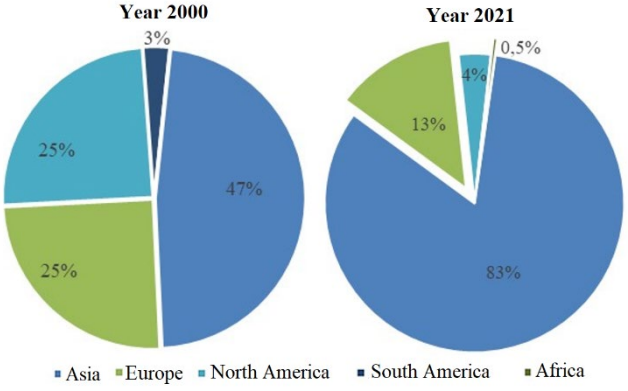

Fig. 7. Structure of global casting production in the years 2000 and 2021 by continent [44, 64]

Changes in casting production volumes in the years 2000–2023 are presented as follows:

— with reference to worldwide production and Poland in Figure 8;

— with reference to the three countries that are currently the largest casting producers (China, India, and the USA) in Figure 9;

— with reference to the largest casting producers in Europe and Poland in Figure 10.

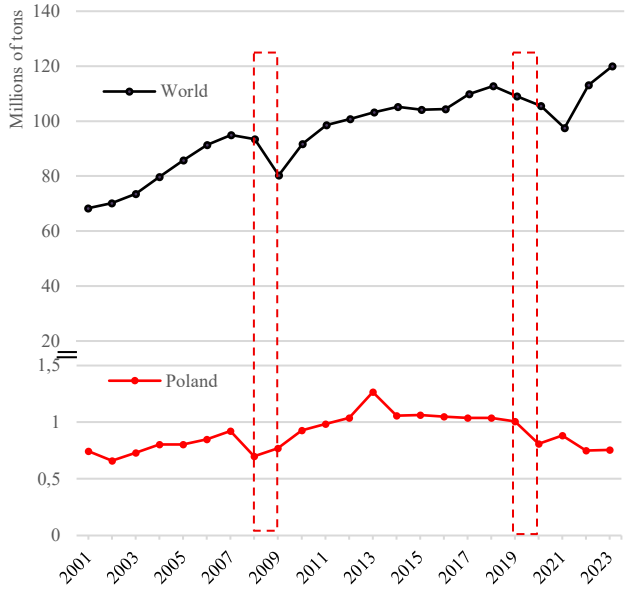

Fig. 8. Casting production volumes worldwide and in Poland in the years 2000–2023 [45–66]. The years of crises are marked with dashed lines (the economic crisis in 2008–2009 and the crisis caused by the COVID-19 pandemic in 2019–2020)

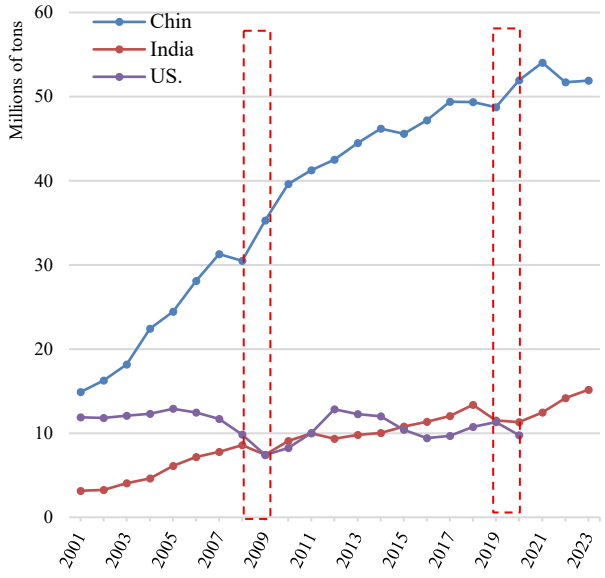

Fig. 9. Casting production volumes in China, India, and the USA in the years 2000–2023 [45–66]. The years of crises are marked with dashed lines (the economic crisis in 2008–2009 and the crisis caused by the COVID-19 pandemic in 2019–2020)

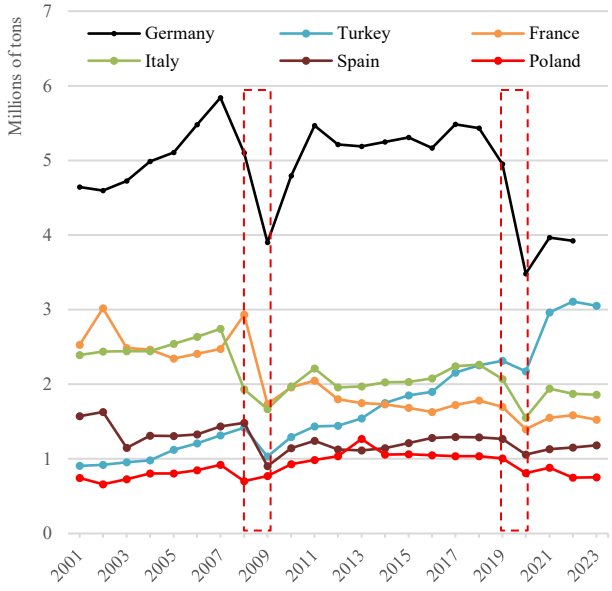

Fig. 10. Casting production volumes in Germany, Turkey, France, Italy, Spain, and Poland in the years 2000–2023 [45–66]. The years of crises are marked with dashed lines (the economic crisis in 2008–2009 and the crisis caused by the COVID-19 pandemic in 2019–2020)

The analysis of the data presented in Figures 8–10 shows that in the years of the two crises that occurred in the 21st century, which were accompanied by a distinct decrease in production levels worldwide (also in a number of the largest casting-producing countries), an increase in production was recorded only for the two currently largest producers of castings (China and India). Changes in production volumes worldwide and in China, India, the USA, Germany, and Poland in the years 2008–2009 and 2019–2020 are presented in Table 2.

The total casting production volumes in the years 2001–2023 and the average annual growth rates of these volumes in the countries belonging to the group of leaders, as well as in Poland, are summarised in Table 3.

Table 2.
Changes in production volumes worldwide and in China, India, the USA, Germany, and Poland in the years 2008–2009 and 2019–2020 [52, 53, 63, 64]

Economy	Changes in production volumes (million tonnes)	
	2008-2009	2019-2020
World	decrease of approx. 13.11	decrease of approx. 3.55
China	*increase of approx.1,8*	*increase of approx. 3.20*
India	*increase of approx. 1.1*	*increase of approx. 0.2*
USA	decrease of approx. 3.38	decrease of approx. 1.56
Germany	decrease of approx. 2.10	decrease of approx. 1.47
Poland	decrease of approx. 0.17	decrease of approx. 0.20

It should be noted that despite China's achievement of a globally dominant leadership position in casting production, the Indian industry recorded the highest average annual growth rate of casting production in the years 2001–2023. This rate was 7.4%, while for China it was 5.8%. The Turkish industry showed a slightly lower rate (5.7%).

In the subsequent Table 4, the total casting production volumes in the years 2001–2023 from grey cast iron, spheroidal graphite cast iron, steel castings, and aluminium alloys are presented, as well as the average annual growth rates of production volumes from these materials in the period under consideration.

The data compiled in Table 4 show, among others, that China is currently the largest producer of castings worldwide, and this for each of the analysed materials. On the other hand, the Indian industry recorded the highest average annual growth rate of ferrous alloy casting production in the years 2001–2023. It can only be assumed (due to the lack of data on aluminium alloy casting production in India in 2023) that with respect to aluminium alloys, casting production grew fastest in the years 2001–2023 in Turkey, China, and Poland; the average annual growth rate of production volumes in these countries amounted to 13.6%, 10.5%, and 8%, respectively.

Concluding the discussion of casting production in the 60-year period under consideration, it is worth adding that in 2023 there were 449 foundries operating in Poland [11]. This number included 239 non-ferrous metal foundries, 176 iron foundries, and 35 steel foundries. There are no data available concerning the number of foundries operating in 2024.

Table 3.
Total casting production volumes in the years 2001 and 2023 and average annual growth rates of these volumes in the leading countries and in Poland [45, 65, 66]

Country	**Production (tonnes)**		**Share in world production (%)**		**Average annual growth rate in 2001–2023 (%)**
	2001	**2023**	**2001**	**2023**	
China	14,888,992	51,900,000	*21.80%*	*43.25%*	*5.8%*
India	3,155,000	15,160,000	*4.62%*	*12.63%*	*7.4%*
USA	11,871,000	-	*17.38%*	-	-
Germany	4,643,430	3,911,742	*6.80%*	*3.26%*	*-0.8%*
Turkey	905,800	3,050,404	*1.33%*	*2.54%*	*5.7%*
France	2,527,146	1,523,671	*3.70%*	*1.27%*	*-2.3%*
Italy	2,393,337	1,859,967	*3.50%*	*1.55%*	*-1.1%*
Spain	1,572,300	1,181,589	*2.30%*	*0.98%*	*-1.3%*
Poland	745,200	754,078	*1.09%*	*0.63%*	*0.1%*
World	68,311,197	120,000,000	-	-	*2.6%*

Table 4.
Total casting production volumes of grey cast iron, spheroidal graphite cast iron, steel castings, and aluminium alloys in the years 2001 and 2023, and average annual growth rates of these volumes in the leading countries and in Poland [45, 64–66]

Country	Production (tonnes)			Share in world production [%]		Average annual growth rate in 2001–2023 (%)
	2001	2021	2023	2001	2021	
Grey cast iron						
China	9,002,844	22,550,000	20,900,000	*24.20%*	*51.50%*	*3.9%*
India	285,000	1,259,850	1,610,000	*0.77%*	*2.88%*	*8.2%*
USA	4,562,100	7,616,824	-	*12.27%*	*17.40%*	-
Germany	2,303,089	1,873,700	1,836,900	*6.19%*	*4.28%*	*-1.0%*
Turkey	615,000	920,700	868,000	*1.65%*	*2.10%*	*1.6%*
France	2,012,184	503,900	470,300	*5.41%*	*1.15%*	*-6.4%*
Italy	966,432	616,200	610,900	*2.60%*	*1.41%*	*-2.1%*
Spain	576,200	322,800	375,600	*1.55%*	*0.74%*	*-1.9%*
Poland	495,000	392,400	339,540	*1.33%*	*0.90%*	*-1.7%*
World	37,194,171	43,786,115	-	-	-	*0.8%**
Spheroidal graphite cast iron						
China	2,730,160	15,950,000	15,050,000	*20.56%*	*64.25%*	*8.1%*
India	285,000	1,259,850	1,610,000	*2.15%*	*5.08%*	*8.2%*
USA	3,591,000	-	-	*27.04%*	-	-
Germany	1,269,392	1,140,900	1,103,900	*9.56%*	*4.60%*	*-0.6%*
Turkey	132,000	1,108,100	1,191,400	*0.99%*	*4.46%*	*10.5%*
France	-	665,000	650,300	-	*2.68%*	-
Italy	378,664	385,900	360,300	*2.85%*	*1.55%*	*-0.2%*
Spain	617,000	608,800	585,000	*4.65%*	*2.45%*	*-0.2%*
Poland	105,200	135,160	117,886	*0.79%*	*0.54%*	*0.5%*
World	13,279,921	24,822,992	-	-	-	3.2%*
Steel castings						
China	1,590,328	6,600,000	6,350,000	*24.94%*	*72.56%*	*6.5%*
India	310,000	1,049,827	1,360,000	*4.86%*	*11.54%*	*7.0%*
USA	1,058,400	-	-	*16.60%*	-	-
Germany	189,394	143,800	136,700	*2.97%*	*1.58%*	*-1.5%*
Turkey	107,000	279,300	255,600	*1.68%*	*3.07%*	*4.0%*
France	129,328	43,100	49,400	*2.03%*	*0.47%*	*-4.3%*
Italy	77,441	56,800	60,800	*1.21%*	*0.62%*	*-1.1%*
Spain	78,500	69,200	84,700	*1.23%*	*0.76%*	*0.3%*
Poland	54,500	43,600	35,060	*0.85%*	*0.48%*	*-2.0%*
World	6,376,642	9,096,308	-	-	-	*1.8%**
Aluminium alloys						
China	878,287	7,200,000	7,950,000	*10.74%*	*49.16%*	*10.5%*
India	230,000	1,465,158	-	*2.81%*	*10.00%*	-
USA	1,719,000	-	-	*21.02%*	-	-
Germany	652,178	701,118	740,610	*7.97%*	*4.79%*	*0.6%*
Turkey	39,925	578,113	660,832	*0.49%*	*3.95%*	*13.6%*
France	315,494	299,016	314,267	*3.86%*	*2.04%*	*0.0%*
Italy	751,000	727,254	687,213	*9.18%*	*4.97%*	*-0.4%*
Spain	253,300	106,185	114,618	*3.10%*	*0.72%*	*-3.5%*
Poland	46,000	296,480	250,000	*0.56%*	*2.02%*	*8.0%*
World	8,178,319	14,646,341				*3.0%**

** The result refers to the years 2001–2021.*

4. Summary

In the first fifteen years of the analysed period, the volume of worldwide casting production was characterised by considerable variability (see Fig. 1). From the mid-1980s, a clear upward trend emerged; in 2023, about 120 million tons of castings were produced worldwide. In the case of Polish foundry production, the maximum output (about 2.5 million tons) occurred in the mid-1970s (see Fig. 2). After a gradual decline in production volume to below 1 million tons annually, an upward trend has been observed since 2002. In the years 2010–2019, about 1 million tons of castings were produced annually in Poland, while in the years 2020–2023 casting production amounted to about 0.75–0.8 million tons per year. Based on the collected data, it should be noted that casting production has shifted from Europe and the USA to Asian countries, mainly China and India. The former has become the leader in global casting production in recent years; however, the highest average annual growth rate of casting production was recorded in the Indian industry.

Among the basic foundry materials, the production of spheroidal graphite cast iron castings and aluminium alloy castings increased the most in the past 20 years. In the case of aluminium alloys as a casting material, production in Poland increased to the greatest extent. The average annual growth rate of aluminium alloy casting production in Poland in the years 2001–2023 was 8%, and its share in world production in 2023 exceeded 2%.

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