



FERROALLOY PRODUCTION AND CONSUMPTION IN TÜRKİYE

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ABSTRACT

Turkish iron and steel sector, the base of which was established in the 1930's, plays an important role in the industrialization and development of the country's economy. In Türkiye this sector is the major consumer of ferroalloys. There had been a great improvement in Turkish Iron and Steel industry, especially after the 1980's and as a result, 20.9 million tons of yearly crude steel production placed Türkiye 11th in the global steel output and 3rd in Europe. 15 % of steel produced in Türkiye is flat products, while the long products make the rest. The product composition and the general characteristics of steel production process led to an increase in ferroalloy consumption. Domestically consumed ferroalloys are especially ferromanganese, silicomanganese, and ferrosilicon. As of today, ferroalloy production capacity of Türkiye is 173,800 tons/year; 161,500 tons of which is ferrochrome with high and low carbon grades, 7,300 tons of ferrosilicochrome and the rest is ferrosilicon (5,000 tons/year). Türkiye is one of leading ferrochrome producers in the world considering the above mentioned production figures. However, this production is mainly exported since Türkiye's stainless steel production level is modest requiring low amounts of ferrochrome. The products of iron and steel industry in Türkiye require large quantities of other ferroalloys, which make Türkiye a major importer and exporter of ferroalloys. The aim of this work is to present production, consumption, import and export quantities of: ferrochrome, ferromanganese, ferrosilicon, ferromolybdenum, ferrotungsten, ferrotitanium and ferrovandium of Türkiye, between 1990 and 2006.

1. INTRODUCTION

Ferroalloy production capacity of Türkiye is 173,800 t/y. 161,500 t/y of this capacity belongs to both low- and high-carbon ferrochrome productions (LCFeCr & HCFeCr), while the rest (12,300 t/y) is of ferrosilicon (FeSi) and ferrosilicochrome (SiCr) production. The main reason of building FeCr plants in Türkiye is to exploit the rich chromite ores of Türkiye and to export a value added product instead of simply the ore itself. The reason of significantly small ferrochrome consumption is due to the fact that the proportion of stainless steel production within the country is very limited.

World chromite reserves are 7.6 billion tons with approximately 45 % Cr₂O₃ content. Turkish chromite reserves, in comparison are about 30.4 million tons, making 0.4 % of the world [1].

In the field of FeCr production in Türkiye, technological process followed is quite satisfactory and on the same level with other FeCr producing countries but domestic production is rather costly due to more expensive energy and financial difficulties. However, Türkiye still has a great competitive potential owing to its raw material resources.

Long products constitute 85 % of the steel production in Türkiye, while standard flat products make the rest. Alloyed and quality steels have a share of only 2 % in this production. Due to these characteristics of Turkish steel production, bulk ferroalloys consumed domestically are imported i.e.: ferromanganese (FeMn),

silicomanganese (SiMn), and ferrosilicon (FeSi). There are no deposition of manganese and energy being more expensive it is more economical to import FeMn, SiMn and FeSi.

2. FERROALLOY PRODUCTION IN TÜRKİYE

LC and HCFeCr, SiCr and FeSi are produced by two different companies in Türkiye. Eti Holding Ltd., a state-owned company was privatized in 2004. One of the companies produces HCFeCr in Elazığ, while the other produces LCFeCr, SiCr and FeSi in Antalya. Table 1 lists these plants and their capacities. 161,500 t/y of ferroalloy production capacity belongs to ferrochrome productions and 7,300 t/y of ferrosilicochrome (SiCr) is used in LCFeCr production.

HCFeCr production is carried out in two open-type submerged arc furnaces each with transformer rating of 17,000 kVA, having a total capacity of 50,000 t/y. In later addition, there are two closed type submerged arc furnaces each of 30,000 kVA having a total capacity of 100,000 t/y [4]. Since the furnaces are closed the heat of exhaust gases is utilized in a pre-heating furnace giving about 20 % savings in energy consumption.

Table 1: Ferroalloy producing plants in Türkiye

Place	Product Type	Capacity (t/y in 2006)
Antalya	LCFeCr	11,500
Antalya	FeSi	5,000
Antalya	SiCr	7,300
Elazığ	HCFeCr	150,000

LCFeCr production is conducted in two steps. In the first step, SiCr is produced from HCFeCr, quartzite (95 % SiO₂), scrap iron (or iron ore) and metallurgical coke in a submerged arc-furnace of 7,500 kVA, containing roughly 45 % Si. In the second step, a rich calcium oxide chromite slag is prepared in an arc-furnace of 6,500 kVA, containing approximately 29-30 % Cr₂O₃. This slag, rich in chromium, is mixed with SiCr of the first step in ladles to produce LCFeCr, via silicothermic reduction process. SiCr is manufactured as a by-product during the production of LCFeCr. FeSi (75 % Si) production is carried out in a 6,000 kVA arc furnace.

In 2000, Türkiye produced 89,843 tons of ferrochromium, supplying 1.6 % of the world production (5.7 million tons). In 2004, approximately 6.6 million tons of FeCr was produced worldwide and 28,701 tons that is 0.45 % of it was achieved in Türkiye. Ferroalloy production figures are tabulated in Table 2. FeSi was not produced since 2000 and production quantities of HCFeCr showed a significant decrease after 2001 due to the privatization processes.

Table 2: Ferroalloys production of Türkiye (t/y) [3,5,6]

	1985	1990	1995	2000	2001	2002	2003	2004	2005
HCFeCr	42,000	51,240	80,000	78,703	51,591	3,112	26,459	19,971	21,840
LCFeCr	11,330	10,600	8,550	11,140	9,255	11,200	10,790	8,730	9,533
SiCr	6,841	6,790	5,690	7,050	5,895	7,245	6,715	5,560	6,695
Fe-Si	5,170	5,225	3,900	-	-	-	-	-	-
Total	65,341	73,855	98,140	96,893	66,741	21,557	43,964	34,261	38,068

3. HISTORY OF STEEL PRODUCTION AND FERROALLOYS CONSUMPTION IN TÜRKİYE

The first integrated iron and steel plant of Türkiye, Karabük Iron and Steel Works (KARDEMİR), began to operate in 1937, with a modest capacity of 150,000 t/y. In order to meet the demand for flat products, the second integrated plant, Ereğli Iron and Steel Works (ERDEMİR) started production in 1965, while in 1977 İskenderun Iron and Steel Works (İSDEMİR), Türkiye's third integrated iron and steel plant came on line to meet the demand for long products and semi-finished products. Along with these three state-owned works,

with the increase in the number of the private sector’s electric arc mills after the 1960’s, 18 private companies, the production capacity of the Turkish iron and steel industry which was 4.2 million tons in 1980, has increased to 24.7 million tons in 2005.

In 1980, Türkiye produced 2.5 million tons of steel, supplying 0.35 % of the world production (ranking 33rd in the world). In 2005, 20.9 million tons of steel production was realized which placed Türkiye 11th in the world, making 1.85 % of the world production of 1131.8 million tons [7].

Table 3 shows the distribution of crude steel production in Türkiye, between 1980 and 2005, according to the process by which it is produced. As seen, the share of the integrated steel works in the total is decreasing since 1980, while that of plants with electric arc furnaces (EAF) is increasing very rapidly. In 2005, while EAF’s were producing 72 % of the steel in Türkiye, BOF’s share was only 28 % (Figure 1). Figure 2 shows the amounts of various steel products. As seen, 892,000 tons of flat and 1,643,000 tons of long products manufactured in 1980, making the share of flats 35 % in total. However, this percentage dropped to 15 % by 2005, as the products of new plants, built after 1980’s, were generally long. The balance between production and consumption could not be achieved and the structure formed was contrary to the world’s trend.

Table 3: Türkiye’s total crude steel production by processes [x1000 tons] (8,9)

	1980	1982	1984	1990	1995	2000	2001	2002	2003	2004	2005
EAF	658	1,071	1,464	4,974	8,518	9,096	9,703	11,334	12,546	14,646	14,847
BOF	1,312	1,566	2,375	3,902	3,621	5,229	5,278	5,133	5,753	5,832	6,117
OH	565	540	501	605	606	0	0	0	0	0	0
Total	2,535	3,177	4,340	9,454	12,475	14,325	14,981	16,467	18,299	20,478	20,964

In 2005, 15 % of the steel produced in Türkiye was flat products, while long products’ share was 85 %, a 2 % of which was special steel. Flat products of Türkiye are tinplate, cold rolled sheet, hot rolled sheet, coated sheet and strip. Long products, meanwhile, are round bar, reinforced bar, rail, wire, wire rod, profile and special steel.

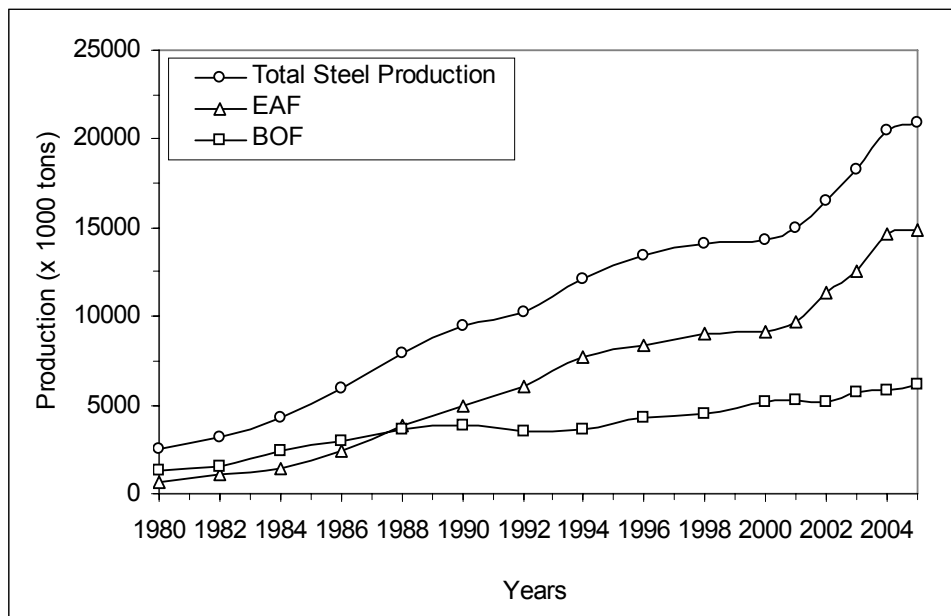


Figure 1: Crude steel production of Türkiye by the process [8,0]

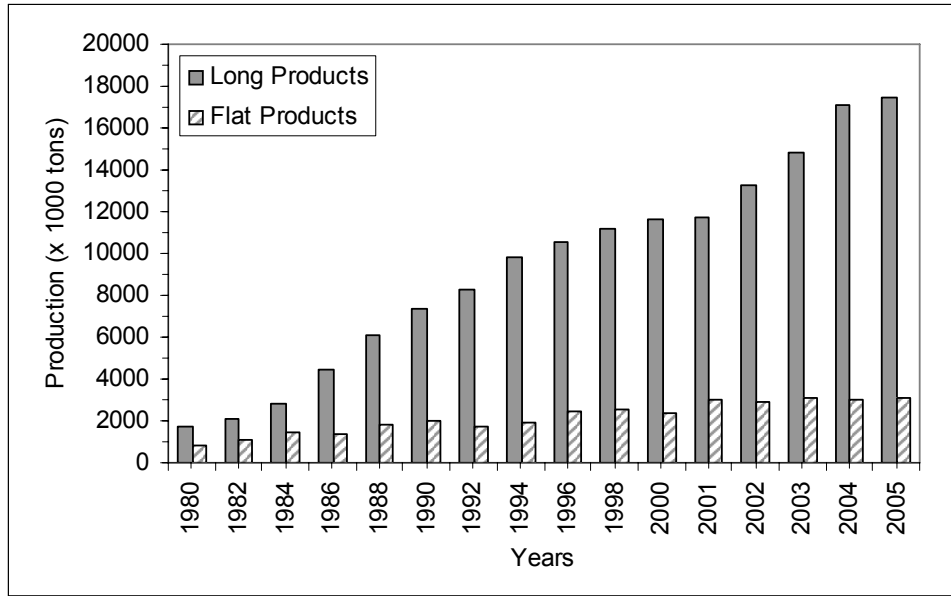
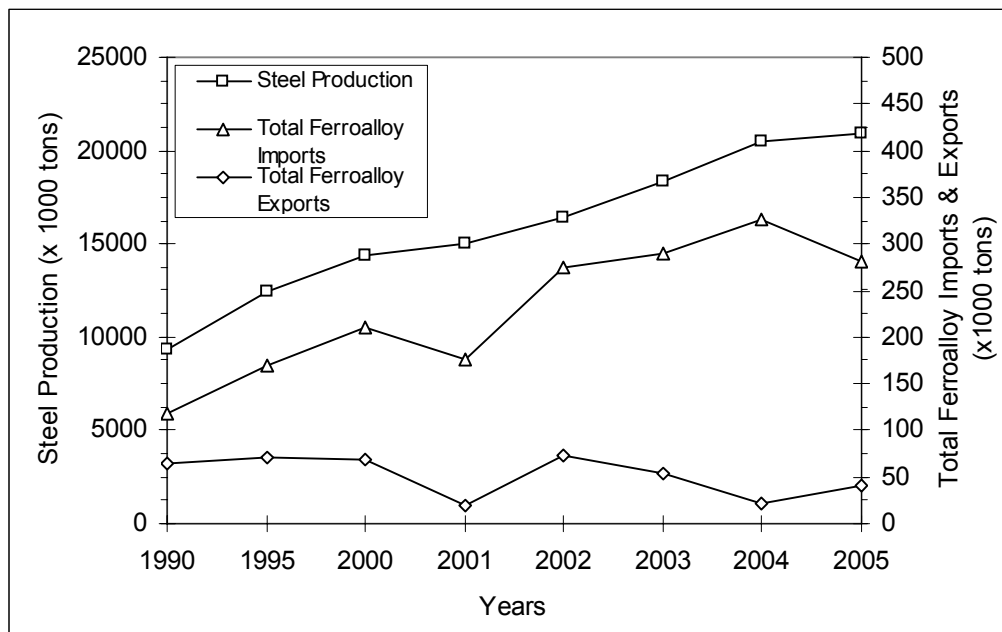


Figure 2: Long and flat steel products manufactured in Türkiye [8,9]

The major consumed ferroalloys in Türkiye are manganese and silicon alloys, depending on the type of steel production. In 1998, about 14.2 million tons of steel was produced, while ferroalloy consumption was 212,000 tons, whereas, it was approximately 350,000 tons in 2005 as 20.9 million tons of steel was produced, a 65 % increase in seven years, in proportion to the increase in steel production. While, a 30.2 % of this consumption was FeSi, 13 % FeMn, and 53 % SiMn in 1998, 20.5 % of this consumption was FeSi, 15.5%



*Temporary figures for 2005

Figure 3: Ferroalloy imports & exports and the crude steel production of Türkiye [9, 10]

FeMn and 58.3 % SiMn in 2005. Demand for ferroalloys has been on the rise over the years, according to the development in steel production.

4. IMPORTS AND EXPORTS OF FERROALLOYS

Ferroalloy imports of Türkiye displayed approximately 40 % increase since 1990, as the domestic crude steel production increased rapidly. On the other hand, ferroalloy exports, displayed 35 % decrease. Figure 3 shows the ferroalloy exports and imports and the crude steel production of Türkiye, while Table 4 displays the total imports and exports in detail for 2005.

4.1 Ferroalloy Exports

Most of FeCr, produced at two completely privatized plants is exported, due to the very low domestic consumption (Figures 4 and 5). The most important markets for our FeCr products are EEC countries, Middle East countries and China. FeSi production is already inadequate to supply local needs, thus it is not exported.

HCFeCr exports displayed a significant decrease after 1999 due to the initiation of privatization process. In 2005, 31,105 tons of HCFeCr was exported. In 1999 the major HCFeCr exports were as follows: U.S.A. (38 %), Belgium (23 %) and Japan (16 %), while in 2005 major export countries replaced by China (79 %) and Holland (12 %).

LCFeCr exports roughly remained unchanged. In 2005, 2,035 tons of LCFeCr was exported. Markets for Turkish LCFeCr exports are usually the European and the Middle East countries. In 1999 Belgium was the major importing country of Turkish LCFeCr (85 %), followed by Sweden (9.5 %) and Italy (2.7 %), on the other hand, the largest export in 2005 was made to Holland (50 %), followed by Italy (12 %) and Pakistan (11 %).

Table 4: Ferroalloys imports & exports for 2005 [10]

Imports	HCFeCr	3,410 tons
	LCFeCr	2,033 tons
	SiMn	163,939 tons
	FeMn	43,743 tons
	FeSi	57,736 tons
	FeMo	1,252 tons
	FeSiMg	2,938 tons
	FeP	1,710 tons
	FeV	425 tons
	FeTi & FeTiSi	447 tons
	FeW & FeWSi	4 tons
	Other Ferroalloys	3,476 tons
	TOTAL	281,113 tons
Exports	HCFeCr	31,104 tons
	LCFeCr	7,934 tons
	Other Ferroalloys	1,356 tons
	TOTAL	40,394 tons

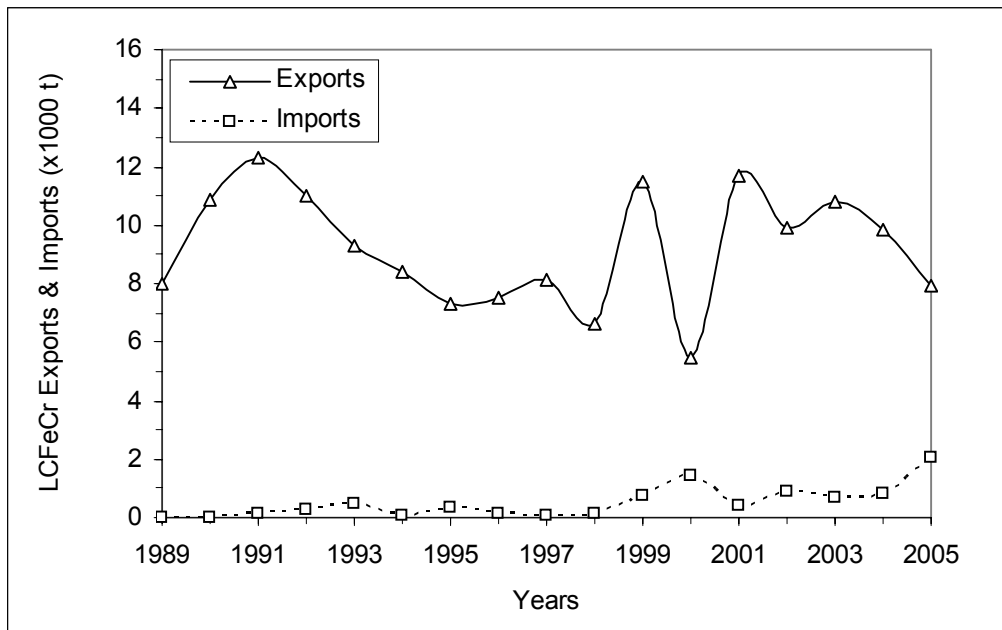


Figure 4: Imports & Exports of HCFeCr [10]

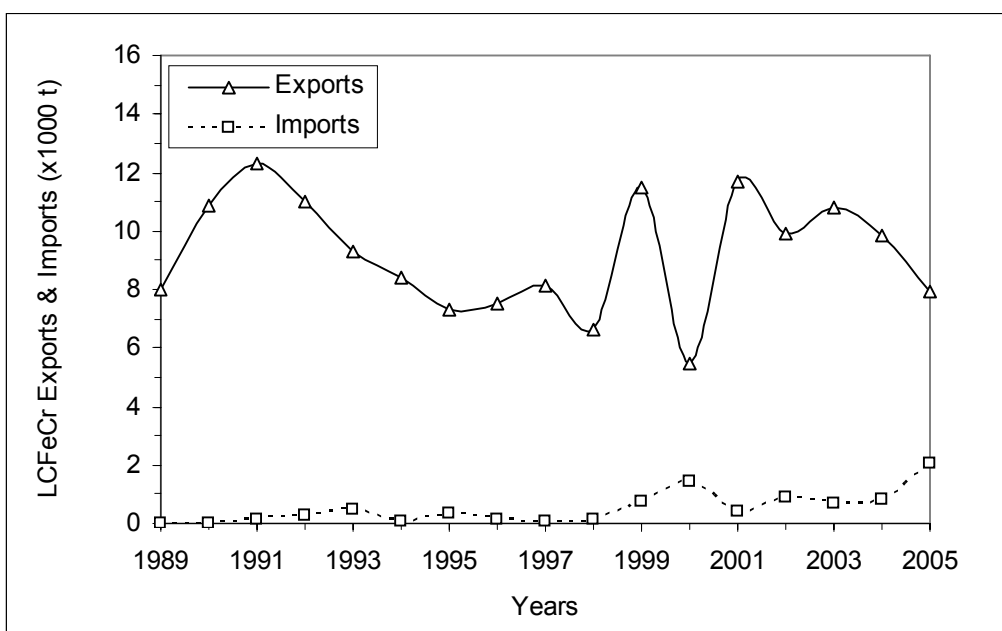


Figure 5: Imports & Exports of LCFeCr [10]

4.2 Ferroalloy Imports

HCFeCr imports showed an important increase after 1999. In 1999, 1,655 tons of HCFeCr was imported while, this amount increased over 3,400 tons in 2005. Today, HCFeCr is imported mainly from Germany (56 %) and Sweden (20 %).

LCFeCr imports began to increase especially after 1998. In 1999, 735 tons of LCFeCr was imported, while, 2,033 tons in 2005. LCFeCr imports are made today from Holland (41 %) and Russia (34 %).

The yearly changes in imports of three largely consumed ferroalloys in Türkiye are given in Figure 6. This trend is expected to continue provided that the composition of Turkish steel production remains unchanged.

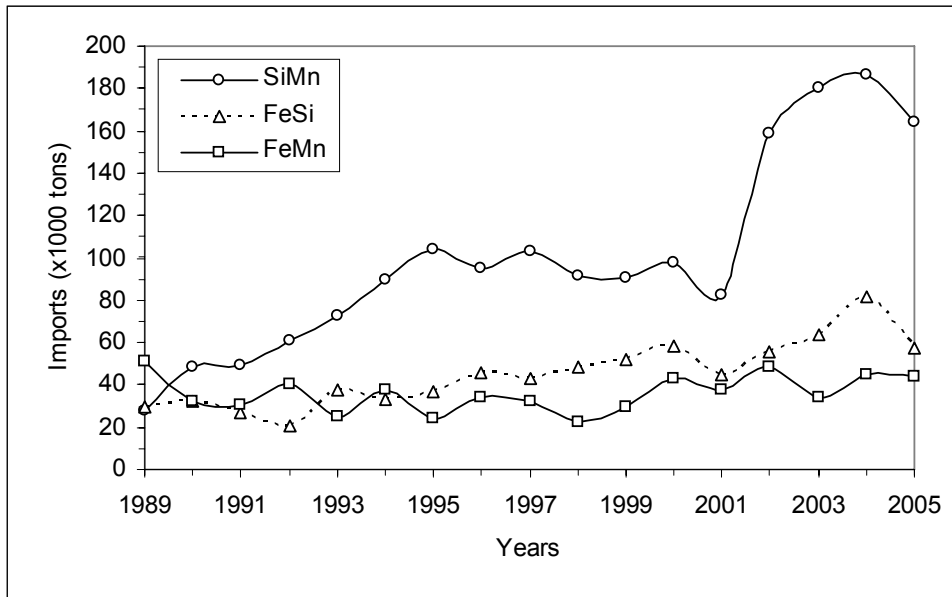


Figure 6: Imports of SiMn, FeMn and FeSi [10]

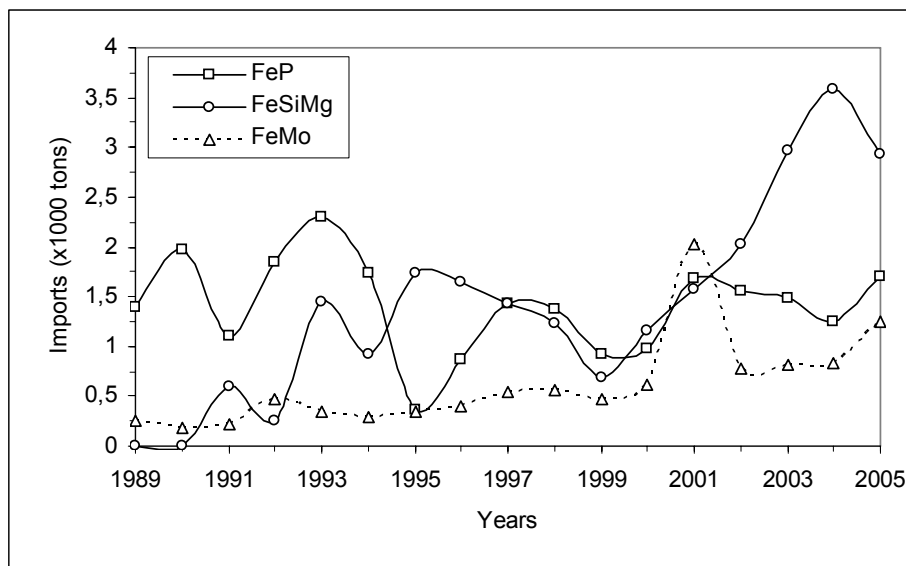


Figure 7: Imports of ferromolybdenum, ferrosilicon magnesium and ferrophosphorous [10]

57,736 tons of FeSi is imported mainly from Ukraine (27 %) and Macedonia (24.5 %) in 2005. FeSi imports remained unchanged over the years. 43,743 tons of FeMn is imported in 2005, as the imports are not changed as before years. In 1999, South Africa was the first country of FeMn imports with 68 %, followed by Norway (16.3 %) and France (9.4 %). Today, the major FeMn imported countries are: South Africa (27 %) and Ukraine (18 %). SiMn imports displayed a significant increase after 2001. 163,939 tons of SiMn is imported in 2005. SiMn imports are made today from Ukraine (55 %), Romania (18 %) and Georgia (15 %).

These minor ferroalloys, import quantities of which are given in Figure 7 and 8 for the period of 1989 and 2005, are mostly used in casting sector. Ferromolybdenum is imported from China, whereas FeSiMg from Norway and Brazil, FeP from China, FeTi from Russia, FeW from China and Holland.

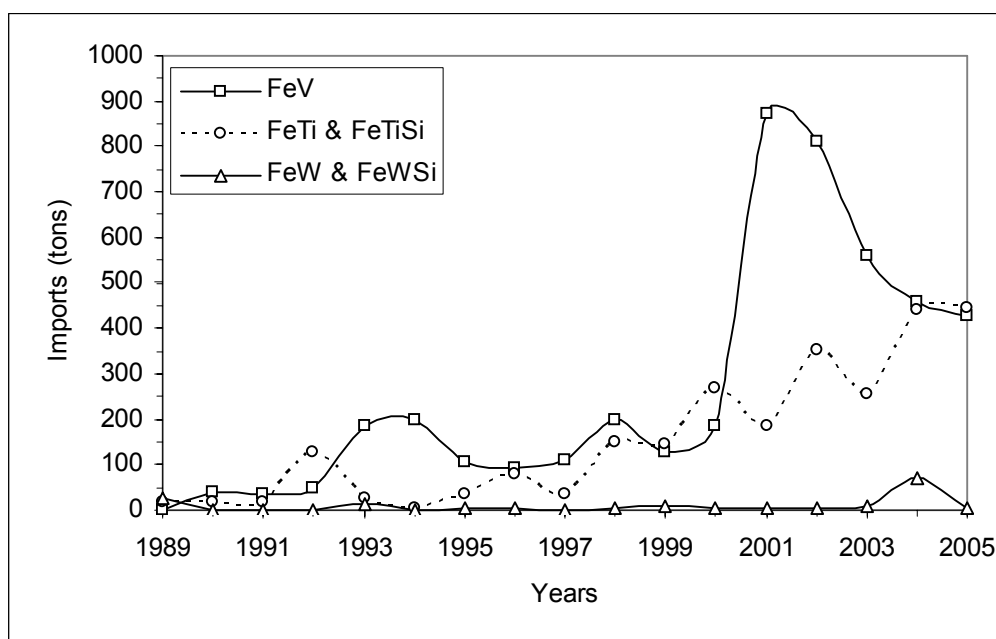


Figure 8: Imports of ferrosilicon-titanium, ferrovanadium and ferrosilicon-tungsten [10]

5. CONCLUSION

Today, Turkish steel production reaches 20.9 million tons/year. Increase in steel production caused ferroalloy consumption to escalate. Long products constitute 85 % of the steel production in Türkiye, 2 % of this share is special steels whereas standard flat products make the rest, 15 %. The product composition and the general characteristics of steel production process lead to an increase in ferroalloy consumption while domestically consumed ferroalloys are especially imported ferromanganese, silicomanganese, and ferrosilicon. This picture of the ferroalloys is not expected to change in the near future of Türkiye. Although, very competitive in terms of its production and quality in world markets, ferrochrome produced in Türkiye is totally exported, since the stainless steel and alloyed steel production within the country are very limited due to the high investment costs and difficulties in production processes.

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