USGS
science for a changing world

2020 Minerals Yearbook

NICKEL [ADVANCE RELEASE]

U.S. Department of the Interior
U.S. Geological Survey

April 2025

U.S. Geological Survey, Reston, Virginia: 2025

Nickel

By Andrew A. Stewart

Domestic survey data and tables were prepared by Tiffany J. Lin, statistical assistant.

In 2020, domestic production of nickel in concentrate was 16,700 metric tons (t). The concentrate was exported to smelters in Canada and other countries. Shipments of purchased scrap, containing 101,000 t of nickel, decreased by 10% from 113,000 t (revised) in 2019 (tables 1, 2).

Reported nickel consumption (primary plus secondary) in the United States in 2020 decreased by 17% to 182,000 t compared with 218,000 t (revised) in 2019 (table 1). U.S. apparent consumption of primary nickel was 94,100 t, 4% of the 2.39 million metric tons (Mt) of world consumption reported by the International Nickel Study Group (INSG; 2023, p. A–1). Nickel alloy and stainless-steel production accounted for 42% and 45% of U.S. reported primary nickel consumption (table 4), respectively, in contrast with 5% and 72%, respectively, globally (Roskill Information Services Ltd., 2021, p. 308). This difference was likely a reflection of the large number of specialty metal companies and a readily available supply of stainless-steel scrap in the United States.

In 2020, reduced domestic consumption of nickel and other commodities could be attributed to the effects of the global coronavirus disease 2019 (COVID-19) pandemic. Although mines were generally deemed essential industries, and therefore remained open, decreased demand from downstream industries led to decreased production in some cases. Most of the reduced nickel consumption was for nickel alloys, mainly those used in the aviation and oil and gas sectors (McRae, 2021; U.S. Geological Survey, 2021, p. 5).

In this chapter, primary nickel refers to a nickel product produced from the beneficiation and processing of mined ore that is ready for use in a downstream consuming industry. However, some smelters and refineries add nickel-containing scrap to mined feed materials. The form and composition of the primary product are typically a function of the mineralogy of the ore deposit and types of processing used. Unwrought nickel metal in all forms [for example, briquet, cathode (electrolytic), flake, pellet, powder, rondelles, and so forth] discussed in this chapter has a purity of more than 99% nickel and generally conforms to the INSG's definition of Class I nickel. Iron- and nickel-containing products, such as ferronickel and nickel pig iron (NPI), and nickel oxide sinter have a purity less than 99% nickel and generally conform to the INSG's definition of Class II nickel (International Nickel Study Group, 2020, p. ii). Specifications for nickel traded on the London Metal Exchange Ltd. (LME) require a purity of 99.8% nickel (ASTM International standards) (London Metal Exchange Ltd., The, undated). Nickel chemicals and salts are also often produced at nickel refineries but are differentiated from production of metal whenever feasible.

Government Actions and Legislation

U.S. Coinage.—Dimes, half dollars, nickels, one-dollar coins, and quarters contain nickel in the form of either cupronickel or manganese-brass alloy. Total nickel consumption for coin production was 3,867 t in 2020, a 51% increase compared with 2,558 t in 2019 (U.S. Mint, undated a, b).

Production

The United States had one active nickel mine, the underground Eagle Mine, in the Upper Peninsula of Michigan, which began operation in 2014. In 2020, the Eagle Mine produced 16,700 t of nickel in concentrate, a 24% increase compared with 13,500 t in 2019 (Lundin Mining Corp., 2021, p. 3).

Limited quantities of byproduct nickel were recovered at Sibanye Gold Ltd.'s (Roodepoort, South Africa) [a subsidiary of Sibanye-Stillwater Ltd. (Johannesburg, South Africa)] base-metal refinery in Columbus, MT. Leading processors of recycled nickel included International Metals Reclamation Co. Inc.'s (INMETCO's) [owned by American Zinc Recycling LLC (Pittsburgh, PA)] secondary smelter in Ellwood City, PA, and Gladieux Metals Recycling, LLC's (Freeport, TX) facility in Freeport, TX. The refinery and secondary recovery data from these operations were included with scrap statistics to avoid disclosing company proprietary data (tables 1–5).

No ferronickel was produced from ores in the United States in 2020. Any U.S. ferronickel exports were likely either reexports or material upgraded for special purposes.

Michigan.—In 2020, Lundin Mining Corp. (Vancouver, British Columbia, Canada) produced 16,700 t of nickel concentrate, an increase of 24% compared with 13,500 t in 2019. Ore from the Eagle Mine was processed at the Humboldt mill, which produced separate concentrates of copper and nickel sulfide minerals. The two sulfide concentrates were sent by rail on a dedicated railroad spur from Humboldt Township to the Canadian National Railway line and then to smelters in Canada or to ports for shipment overseas (Lundin Mining Corp., 2020, p. 37–38; 2021).

Lundin's Eagle East project was located approximately 2 kilometers (km) east and 600 meters deeper than the Eagle deposit and part of the same intrusive complex. The company estimated that average copper and nickel ore grades for Eagle East were approximately 60% greater than those in the Eagle deposit. Development of the Eagle East project was expected to extend the mine life to 2025. Mining of the higher grade ore of Eagle East began in the third quarter of 2019 (Lundin Mining Corp., 2020, p. 2, 34–35, 38).

Minnesota.—PolyMet Mining Corp. (St. Paul, MN) continued to advance its copper, nickel, and platinum-group-metal (PGM) NorthMet project. The project was located 10 km south of the town of Babbitt in St. Louis County. Ore mined from a proposed open pit would be shipped to the reconditioned Erie mill near Hoyt Lakes, MN, for processing by flotation to produce a marketable concentrate. In phase 2 of the project, the concentrate would be processed in a new hydrometallurgical plant to be built at the Erie site. In March 2019, PolyMet received a wetlands permit from the U.S. Army Corps of Engineers, which was the last key permit needed to construct and operate the project. The wetlands permit and several other permits issued by the State were subsequently challenged in court which were still unresolved at yearend 2020 (PolyMet Mining Corp., 2021, p. 4–7).

In June 2020, Twin Metals Minnesota LLC (St. Paul, MN) received notice that the Bureau of Land Management had initiated environmental reviews of the project. The project targeted cobalt, copper, gold, nickel, PGMs, and silver mineralization of the Maturi deposit, part of the magmatic Duluth Complex. The company's proposal included development of an underground mine, tailings management facilities, and a plant to produce separate concentrates of copper and nickel and a gravity concentrate containing gold, PGMs, and silver (Twin Metals Minnesota LLC, 2019, cover letter and p. 2–3, 54; 2020).

Missouri.—Missouri Cobalt, LLC (St. Louis, MO) continued progress on a new hydrometallurgical facility for the production of battery-grade nickel and cobalt. In 2018, the company began environmental remediation at the Madison Mine, a former lead mine and Superfund site, and subsequently applied for a permit to mine. The Madison Mine holds an estimated 32,700 tons of recoverable nickel. Since 2019, the company has been producing a cobalt-nickel-copper concentrate at its facility in Fredericktown, MO, by reprocessing tailings from the old mine site (U.S. Environmental Protection Agency, 2019; PR Newswire, 2021; Missouri Cobalt, LLC, undated).

Byproduct Smelter and Refinery Production.—Sibanye Gold mined PGMs from the J-M Reef in Montana's Beartooth Mountains. Concentrates from the company's two mills (East Boulder and Nye) were sent by truck to the smelting and refining complex in Columbus, MT, where a PGM filter cake and byproduct crystalline nickel sulfate containing minor amounts of cobalt were produced (Sibanye Gold Ltd., 2017; Stillwater Mining Co., 2017, p. 7–8, 21).

Secondary Production.—INMETCO (Ellwood City, PA) operated the only secondary smelter in North America dedicated to recovering chromium- and nickel-containing waste and scrap. The smelter produced an iron-base remelt alloy that typically averaged 13% chromium and 12% nickel. Stainless-steel producers used the remelt alloy as a substitute for ferrochromium and ferronickel. INMETCO had the capability to process a wide range of nickel-bearing wastes including flue dust, grinding swarf, mill scale, and shot blast generated during the manufacturing of stainless steel. INMETCO's complex also accepted filter cakes, plating solutions, spent pickle liquor, sludges, and all types of spent nickel-containing batteries (Horsehead Holding Corp., 2015, p. 8–10).

Gladieux Metals Recycling processed spent catalysts from petroleum refineries. The Freeport, TX, facility treated nickel-molybdenum and cobalt-molybdenum hydrotreating catalysts that had been contaminated by nickel and vanadium contained in the crude oil. Gladieux first roasted and leached the spent catalysts to recover the molybdenum and vanadium. The nickel-and-alumina residue then was converted to a marketable nickel-cobalt-molybdenum alloy in a direct-current electric arc furnace (Stephan, 2013).

In 2020, AMG Vanadium LLC (Cambridge, OH), a subsidiary of AMG Critical Materials N.V. (Amsterdam, Netherlands), continued development of a plant to recycle spent petroleum catalysts in Zanesville, OH, similar to the company's existing plant in Cambridge, OH. The company used proprietary roasting and pyrometallurgical processing to produce ferrovanadium and ferronickel-molybdenum, which typically were sold to carbon- and stainless-steel producers. The new plant would effectively double the company's catalyst recycling and ferroalloy production capacity. In 2020, the company announced the signing of a multiyear agreement with a large oil refinery operator to recycle spent catalysts (Newbanks, 2019; AMG Vanadium LLC, 2020).

Consumption

The U.S. Geological Survey (USGS) annual nickel consumption survey was sent to domestic consumers of primary nickel products. Reported primary nickel consumption in the United States was 84,600 t in 2020, a 19% decrease compared with 105,000 t in 2019. The estimated value of reported primary nickel consumption was $1.17 billion, a 20% decrease compared with that in 2019. U.S. industry consumed 11,700 t of ferronickel in 2020, a decrease of 11% from that in 2019 (tables 1, 3).

Stainless Steel and Low-Alloy Steels.—In 2020, stainless-steel producers accounted for 45% of reported primary nickel consumption, 72% of total nickel consumption, and 94% of nickel-containing scrap consumption in the United States. Alloy steels—other than stainless steel—accounted for an additional 4% of U.S. primary nickel use (table 4). Production of raw stainless and heat-resisting steel in the United States decreased by 17% to 2.14 Mt. Production of nickel-bearing grades decreased by 18% to 1.53 Mt compared with that in 2019 and accounted for 71% of total stainless- and heat-resisting-steel production (American Iron and Steel Institute, 2020, 2021). Leading domestic stainless-steel producers included AK Steel Holding Corp. (West Chester Township, OH) [a subsidiary of Cleveland-Cliffs Inc. (Cleveland, OH)], Allegheny Technologies Inc. (ATI) (Pittsburgh, PA), North American Stainless (Ghent, KY) [a subsidiary of Acerinox, S.A. (Madrid, Spain)], and Outokumpu Stainless USA, LLC (Calvert, AL) [a subsidiary of Outokumpu Oyj (Helsinki, Finland)].

In December 2019, Cleveland-Cliffs Inc. announced the acquisition of AK Steel Holding Corp., which was completed in March 2020. The merger combined Cliffs, a leading producer of iron ore pellets, with AK Steel, a leading producer of carbon, stainless, and electrical steel products (Cleveland-Cliffs Inc., 2019, 2020).

In December, ATI announced that it would cease production of standard stainless sheet products by midyear 2021. The

company intended to increase focus on aerospace and defense applications to improve profitability rather than the stainless sheet line, which had revenue margins of less than 1% (Allegheny Technologies Inc., 2020).

Superalloys and Related Nickel-Base Alloys.—Of the primary nickel consumed in the United States in 2020, approximately 42% was used to make high-performance superalloys and related other nickel-containing alloys, primarily for the aerospace, electric power, and petrochemical industries (table 4). Leading domestic producers of these products included ATI, Carpenter Technology Corp. (Philadelphia, PA), Haynes International Inc. (Kokomo, IN), Precision Castparts Corp. (Lake Oswego, OR) [a subsidiary of Berkshire Hathaway Inc. (Omaha, NE)], and Special Metals Corp. (Huntington, WV) (a subsidiary of Berkshire Hathaway).

Batteries.—Nickel began to be more widely used as a battery material beginning with nickel-cadmium (NiCd) batteries in the 1980s. This trend accelerated in the 1990s when Toyota Motor Corp. adopted nickel-metal-hydride (NiMH) batteries for use in the hybrid-powered Prius (Nickel Institute, undated). According to Project Blue Group Ltd. (2024), batteries accounted for an estimated 8% of global primary nickel consumption in 2020, compared with an estimated 6% in 2019.

Nickel was used increasingly in the cathodes of many lithium-ion batteries. In 2020, global lithium-ion battery consumption accounted for an estimated 59% for all nickel-based battery chemistries, followed by NiMH, 38%, and NiCd, 3% (Benchmark Mineral Intelligence Ltd., 2024b). The primary advantage of nickel-containing battery cathodes is higher energy density compared with most non-nickel-containing alternatives, which is especially important for larger capacity batteries used in applications such as electric vehicles and stationary energy storage. Two of the most common nickel-containing cathode formulations are lithium-nickel-cobalt-aluminum (NCA) and lithium-nickel-cobalt-manganese (NCM). Initially, NCM cathodes contained approximately equal amounts of cobalt, nickel, and manganese. In efforts to increase energy density, cathode manufacturers have been increasing the proportion of nickel in the cathode. In 2016, the estimated distribution of nickel use in NCM cathodes was 59% low nickel and 41% mid-nickel. By 2020, the estimated distribution was 75% mid-nickel, 20% low nickel, and 4% high nickel (Benchmark Mineral Intelligence Ltd., 2024a). Ultium Cells LLC (Warren, OH), a joint venture between General Motors Co. (Detroit, MI) and LG Energy Solution, Ltd. (Seoul, Republic of Korea) [a subsidiary of LG Chem, Ltd. (Seoul, Republic of Korea)], announced that it would be using a nickel-manganese-cobalt-aluminum battery chemistry that would add aluminum and more nickel, while decreasing the amount of cobalt by 70% (Berman, 2020). In January 2020, Samsung SDI Co., Ltd. (Yongin-si, Republic of Korea) announced that it would begin building batteries with a greater amount of nickel in 2021. Nickel would account for more than 80% of the cathode, by mass, compared with between 30% and 50% in 2020 (Argus Media Group, 2020g). Additionally, SK Innovation Co., Ltd. (Seoul, Republic of Korea) would supply NCM batteries containing 90% nickel for Ford F-150 electric trucks, which were planned for release in 2023 (Byung-wook, 2020).

Stocks

Global stocks of nickel metal held in LME-approved warehouses increased by 62% to 247,980 t at yearend 2020 compared with 153,318 t at yearend 2019. All stocks in LME-approved warehouses were Class I material (refined products with a nickel content of 99% or greater) (London Metal Exchange Ltd., The, 2019, 2020).

Data collected by the INSG indicated that in December 2020 world nickel producers held 86,100 t of primary nickel stocks, a 7% decrease compared with stocks at yearend 2019 (International Nickel Study Group, 2023, p. A–1). At yearend 2020, U.S. consumer stocks of primary nickel totaled 7,210 t, a 5% increase compared with 6,860 t in 2019 (tables 1, 5).

Prices

According to S&P Global Platts Metals Week, the LME average annual cash price for nickel was $13,772 per metric ton compared with $13,903 per metric ton in 2019 (table 1).

World Review

In 2020, global mine production decreased by 3% to 2.51 Mt. Production from laterite deposits decreased by 6% and accounted for 63% of global mine production. Production from sulfide deposits decreased by 3%, and production from undifferentiated or other deposits increased by 10% from that in 2019 (table 10). Global primary nickel production was 2.25 Mt, essentially unchanged from that in 2019. Production of ferronickel, including NPI, was 1.22 Mt, a slight increase from that in 2019, and accounted for 54% of total primary nickel production. Production of chemicals was 98,400 t, an increase of 31% from that in 2019, and accounted for 4% of total nickel primary production. Production of all other forms of primary nickel decreased in 2020 compared with production in 2019 (table 12).

According to the INSG, world consumption of primary nickel was 2.39 Mt, essentially unchanged from that in 2019 (International Nickel Study Group, 2023, p. A–7). World production of stainless and heat-resisting steel was 50.9 Mt in 2020, a 3% decrease compared with 52.2 Mt in 2019. China was the leading producer of stainless steel, accounting for 59% of world output, and as a result, was also the leading nickel consumer (International Stainless Steel Forum, 2021, p. 8, 13). In 2020, globally stainless steel accounted for about 70% of primary nickel consumption; batteries, 8%; plating, 7%; alloy steels and castings, 7%; nonferrous alloys, 6%; and other applications, 2% (Project Blue Group Ltd., 2024).

Australia.—Australia was the fifth-ranked nickel-producing country in the world in terms of mine output. Mine production was 169,344 t, a 7% increase compared with that in 2019 (table 10). Australia ranked sixth in primary nickel output and its output increased by 9% to 115,800 t in 2020 (table 12). First Quantum Minerals Ltd. (Vancouver, British Columbia, Canada) restarted ore production at the Ravensthorpe Mine in February, and output of concentrate began in April. Operations had been on care-and-maintenance status since 2017. Additionally, the company announced that mining the Shoemaker-Levy ore body

would begin in the first quarter of 2021, which would extend the mine life by another 20 to 25 years (Argus Media Group, 2020d).

In November, Mincor Resources NL (West Perth, Western Australia, Australia) announced that it had begun development of the underground Cassini nickel sulfide mine in the State of Western Australia, with first production expected during midyear 2022. The mine would be the main source of material for a planned restart of the Kambalda nickel concentrator operations, which had been on care-and-maintenance status since 2016 (Argus Media Group, 2020b).

In 2020, OZ Minerals Ltd. (Adelaide, South Australia, Australia) announced the results of an updated prefeasibility study for the West Musgrave copper-nickel project, which increased the expected nickel output by 20% to 26,000 metric tons per year (t/yr) over 26 years. The company planned to complete a feasibility study and make a final investment decision by 2022 (Argus Media Group, 2020a).

Brazil.—In 2020, Brazil's mine production increased by 38% to 77,133 t, and primary nickel production increased by 9% to 58,911 t compared with that in 2019 (tables 10, 12). In October, Brazilian Nickel PLC (London, United Kingdom) announced that it had received an investment of $25 million from the U.S. International Development Finance Corp. through Brazilian Nickel's funding partner, TechMet Ltd. (Dublin, Ireland). The funding would go towards construction and the start of small-scale production of nickel hydroxide and cobalt hydroxide at the Piaui nickel project site. In 2016 and 2017, the company operated a demonstration plant at the site and produced nickel and cobalt products. The main environmental licenses for the full-scale project were obtained in 2019 and 2020 (Brazilian Nickel PLC, 2020, undated).

Canada.—Globally, Canada ranked sixth in nickel mine production and fifth in primary nickel production. Mine production was 167,243 t, a decrease of 8% compared with that in 2019. Primary nickel production was 124,043 t, essentially unchanged from that in 2019 (tables 10, 12). Four Provinces had active nickel mines in 2020—Manitoba, Newfoundland and Labrador, Ontario, and Quebec.

In March, Vale Canada Ltd. (Toronto, Ontario Province), a subsidiary of Vale S.A., placed the Voisey's Bay mining operation on care-and-maintenance status through July, to prevent the potential spread of the COVID-19 pandemic owing to the remoteness of the site, which had higher exposure to air travel. The refinery at Long Harbour remained in operation, using stockpiled material at the site. Vale also continued progress on an underground extension project at the Voisey's Bay Mine, which would increase nickel production to 45,000 t/yr. The company expected to begin production at one of the project mines, Reid Brook, during the first half of 2021 (Vale S.A., 2021, p. 8–9, 88).

China.—China was the leading producer of primary nickel, but ranked seventh in mine production (tables 10, 12), and relied on large quantities of imported nickel ore, concentrate, and intermediate products such as matte, nickel-cobalt hydroxide (often called mixed hydroxide product or MHP by industry), and nickel-cobalt sulfide (often called mixed sulfide product or MSP by industry) to supply its primary production. According to INSG data, most of China's mines were sulfide mines, with reserve grades typically averaging less than 1% nickel (International Nickel Study Group, 2020, p. B–23—B–29). Imports of nickel ore and concentrate were 39.1 Mt (gross weight) in 2020, a decrease of 30% compared with those in 2019. The Philippines and Indonesia were the leading suppliers, accounting for 82% and 9%, respectively (International Nickel Study Group, 2023).

In 2020, China's total primary nickel production was 744,000 t, a decrease of 10% compared with that in 2019, and accounted for 33% of world primary nickel production. Production of NPI, a form of ferronickel with a nickel content less than 15%, decreased by 16% and accounted for 68% of China's production of primary nickel. Production of chemicals increased by 55%, and production of metal decreased by 5% (table 12).

According to INSG data, China was the world's leading consumer of nickel. Consumption was 1.41 Mt of primary nickel, a 6% increase compared with 1.33 Mt in 2019, and accounted for 59% of world consumption in 2020. China's imports of unwrought, unalloyed nickel (Harmonized System code 7502.10) were 131,000 t, a decrease of 32% compared with 193,000 t in 2019. Imports from Russia accounted for 40%, followed by Australia (23%) and Canada (10%). Gross weight imports of ferronickel, which likely included NPI, were 3.4 Mt, an 81% increase from that in 2019. Ferronickel imports from Indonesia more than doubled and accounted for 79% of China's ferronickel imports (International Nickel Study Group, 2023, p. A–7, B).

In 2020, Zhejiang Huayou Cobalt Co., Ltd. (Tongxiang, Zhejiang Province) began construction on a nickel sulfate plant in Quzhou, Zhejiang Province. Nickel sulfate is used in the production of NCM- and NCA-based lithium-ion batteries. The plant was expected to be completed by 2022, with production reaching full capacity by 2024 (Argus Media Group, 2020c).

Colombia.—Mine production in Colombia was 38,700 t, a 14% decrease compared with 45,000 t in 2019 (table 10). Primary nickel production was 36,094 t, an 11% decrease from that in 2019 (table 12). During the fourth quarter of 2020, South32 Ltd. (Perth, Western Australia, Australia) shut down a furnace at the Cerro Matoso Mine to commence refurbishment, which was scheduled for completion by the end of January 2021. Additionally, the company approved development of a mine at Queresas and Porvenir, which was estimated to contain 17 Mt of the total mineral resource estimate for the Cerro Matoso deposit (South32 Ltd., 2021).

Finland.—Mine production in Finland was 41,429 t, an 8% increase compared with 38,530 t in 2019 (table 10). In May, a fire at the crushing plant at the Kevitsa Mine shut down plant production for approximately 1 week. Production resumed on June 5 at about 90% of capacity using mobile crushing plants. Boliden AB (Stockholm, Sweden) estimated that repairs would take 2 to 3 months. In August, Boliden announced an expansion of the nickel line at the Harjavalta smelter, increasing the feed capacity from 310,000 t/yr to 370,000 t/yr (Boliden AB, 2020a, b).

In November, Terrafame Oy (Sotkamo, Finland) [a subsidiary of Suomen Malmijalostus Oy (Helsinki, Finland)] announced a 19% increase to its mineral resources at Sotkamo. The new resource estimate was 1,499 Mt of combined measured, indicated, and inferred resources, containing 3.88 Mt of nickel. The

company also continued construction on a nickel sulfate battery chemical plant and expected to begin commissioning in 2021. The plant capacity would be 170,000 t/yr (Terrafame Oy, 2020).

Indonesia.—In 2020, Indonesia was the leading global producer of mined nickel, with production of 771,000 t, a 10% decrease compared with 853,000 t in 2019 (table 10). The country also was the second-ranked producer of primary nickel globally and a globally significant producer of stainless steel. Primary nickel production was 333,000 t, an increase of 63% compared with that in 2019 (table 12). Increased primary production was the result of the continued development and commissioning of smelters, which had been stimulated through implementation of a ban on the export of unprocessed ore. In 2020, Indonesia had 19 operating smelters, with another 29 in construction. Five smelters under construction were equipped with high-pressure acid-leaching (HPAL) technology and would produce MHP or MSP, which were precursor materials for nickel sulfate used in lithium-ion batteries (CNBC Indonesia, 2020).

In April, PT Weda Bay Nickel (Jakarta, Indonesia) announced that operations had begun at the nickel pyrometallurgical unit. The company, a joint venture between Eramet S.A. (Paris, France), Tsingshan Holding Group Co., Ltd. (Wenzhou, China), and PT Antam Tbk (Jakarta, Indonesia) also had begun operations at a nickel mine in October 2019 (Eramet S.A., 2020).

Huayue Nickel and Cobalt (Jakarta, Indonesia) (subsidiary of Zhejiang Huayou Cobalt Co., Ltd.) began construction on a nickel smelting plant at Morowali in Central Sulawesi Province. The plant would have a capacity of 60,000 t/yr of nickel metal and be developed in two phases of 30,000 t/yr each. The first phase was scheduled for completion in June 2021 (Argus Media Group, 2020e).

Russia.—Russia ranked third in global nickel mine production and fourth in primary nickel production in 2020. Mine production increased slightly to 283,000 t compared with that in 2019, and primary nickel production was 172,357 t, an increase of 4% compared with that in 2019 (tables 10, 12). All production was from the operations of PJSC MMC Norilsk Nickel. The company mined and beneficiated nickel-copper sulfide ores and smelted the concentrates at its Polar Division on the Taymyr Peninsula and at Kola MMC on the Kola Peninsula. Matte from the Polar Division was refined at Kola MMC's Severonickel refinery at Monchegorsk on the Kola Peninsula. Matte from Kola MMC was refined at Severonickel and at Norilsk Nickel Harjavalta Oy in Finland. In December 2020, the company announced that it had begun shutting down its nickel smelter in the town of Nikel in an effort to reduce harmful emissions (PJSC MMC Norilsk Nickel, 2020).

South Africa.—In 2020, mine production was 34,908 t, a decrease of 20% from that in 2019, and primary nickel production was 32,418 t, a decrease of 23% compared with that in 2019 (tables 10, 12). Most nickel production was recovered as a byproduct of PGM mining. On March 26, South Africa began a mandatory lockdown period of 21 days, which included the mining sector, to help slow the spread of the COVID-19 pandemic. Many companies subsequently announced that they would place their mines and furnaces into care-and-maintenance status. On April 9, President Cyril Ramaphosa announced that the lockdown would be extended by 2 weeks, through the end of April (Argus Media Group, 2020f; Ramaphosa, 2020).

Outlook

Stainless steel has been and is expected to continue to be the leading end use of primary nickel, although its share of primary nickel consumption is likely to decrease as a shift to electric vehicles results in increased consumption of nickel in lithium-ion batteries (Backeberg and others, 2020, p. 13).

References Cited

Allegheny Technologies Inc., 2020, ATI exits standard stainless sheet products, redeploys capital to high-return opportunities: Pittsburgh, PA, Allegheny Technologies Inc. news release, December 2, 3 p. (Accessed April 18, 2024, at https://s27.q4cdn.com/226628310/files/doc_news/2020/12/ATI-Exits-Standard-Stainless-Sheet-Products-Redeploys-Capital-to-High-Return-Opportunities.pdf.)

American Iron and Steel Institute, 2020, Quarterly production of stainless and heat resisting raw steel (AIS 104)—Fourth quarter 2019: Washington, DC, American Iron and Steel Institute, 2 p.

American Iron and Steel Institute, 2021, Quarterly production of stainless and heat resisting raw steel (AIS 104)—Fourth quarter 2020: Washington, DC, American Iron and Steel Institute, 2 p.

AMG Vanadium LLC, 2020, AMG Advanced Metallurgical Group N.V. announces long-term spent catalyst recycling agreement: Cambridge, OH, AMG Vanadium LLC news release, January 7. (Accessed April 18, 2024, at https://amg-v.com/news/article/amg-advanced-metallurgical-group-n-v-announces-long-term-spent-catalyst-recycling-agreement/.)

Argus Media Group, 2020a, Australia OZ Minerals raises West Musgrave economics: Argus Media group, Argus Metals International, December 9. (Accessed March 7, 2024, via https://direct.argusmedia.com/.)

Argus Media Group, 2020b, Australia's Mincor starts development of Ni mine: Argus Media group, Argus Metals International, November 16. (Accessed April 22, 2024, via https://direct.argusmedia.com/.)

Argus Media Group, 2020c, China's Huayou starts building nickel sulphate plant: Argus Media group, Argus Metals International, July 20. (Accessed March 7, 2024, via https://direct.argusmedia.com/.)

Argus Media Group, 2020d, FQM eyes long life for Australia's Ravensthorpe nickel: Argus Media group, Argus Metals International, October 6. (Accessed April 25, 2024, via https://direct.argusmedia.com/.)

Argus Media Group, 2020e, Huayue builds laterite nickel plant in Indonesia: Argus Media group, Argus Metals International, March 4. (Accessed March 8, 2024, via https://direct.argusmedia.com/.)

Argus Media Group, 2020f, S Africa's mining sector prepares for 21-day lockdown: Argus Media group, Argus Metals International, March 24. (Accessed March 8, 2024, via https://direct.argusmedia.com/.)

Argus Media Group, 2020g, Samsung SDI sees new batteries boosting nickel demand: Argus Media group, Argus Metals International, January 31. (Accessed March 8, 2024, via https://direct.argusmedia.com/.)

Backeberg, N., Masson, O., Lu, Y., and Anderson, J., 2020, Nickel—Stainless steel vs batteries vs COVID-19: Roskill Information Services Ltd., May, 20 p.

Benchmark Mineral Intelligence Ltd., 2024a, Lithium ion battery database Q1 2024: London, United Kingdom, Benchmark Mineral Intelligence Ltd. (Accessed April 19, 2024, via https://www.benchmarkminerals.com/forecasts/.)

Benchmark Mineral Intelligence Ltd., 2024b, Nickel forecast Q1 2024: London, United Kingdom, Benchmark Mineral Intelligence Ltd. (Accessed April 19, 2024, via https://www.benchmarkminerals.com/forecasts/.)

Berman, Bradley, 2020, GM says its new low-cobalt EV battery cell has 60% more capacity: Electrek.co, March 5. (Accessed April 26, 2024, at https://electrek.co/2020/03/05/gm-says-its-new-low-cobalt-ev-battery-cell-has-60-more-capacity/.)

Boliden AB, 2020a, Effect of the fire at Boliden Kevitsa: Stockholm, Sweden, Boliden AB news release, June 5. (Accessed April 23, 2024, at https://investors.boliden.com/en/press/effect-fire-boliden-kevitsa-1817712.)

Boliden AB, 2020b, Investment in nickel expansion at Boliden Harjavalta: Stockholm, Sweden, Boliden AB news release, August 28. (Accessed April 23, 2024, at https://investors.boliden.com/en/press/investment-nickel-expansion-boliden-harjavalta-1839369.)

Brazilian Nickel PLC, 2020, Brazilian Nickel PLC secures US$ 25 million investment to advance the Piauí Nickel project in Brazil: London, United Kingdom, Brazilian Nickel PLC news release, October 6. (Accessed April 19, 2024, at https://www.braziliannickel.com/brazilian-nickel-plc-secures-us-25-million-investment-to-advance-the-piaui-nickel-project-in-brazil/.)

Brazilian Nickel PLC, [undated], The Piauí Nickel Project is a nickel laterite heap leaching project in the North-east of Brazil: London, United Kingdom, Brazilian Nickel PLC. (Accessed April 19, 2024, at https://www.braziliannickel.com/piaui-nickel-project/.)

Byung-wook, Kim, 2020, SK to commercialize world's 1st NCM battery with 90% nickel: The [Seoul] Korea Herald, August 10. (Accessed May 1, 2024, at http://www.koreaherald.com/common/newsprint.php?ud=20200810000683.)

Cleveland-Cliffs Inc., 2019, Cleveland-Cliffs to acquire AK Steel: Cleveland, OH, Cleveland-Cliffs Inc. news release, December 3. (Accessed April 18, 2024, at https://www.clevelandcliffs.com/news/news-releases/detail/50/cleveland-cliffs-to-acquire-ak-steel.)

Cleveland-Cliffs Inc., 2020, Cleveland-Cliffs completes acquisition of AK Steel: Cleveland, OH, Cleveland-Cliffs Inc. news release, March 13. (Accessed April 18, 2024, at https://www.clevelandcliffs.com/news/news-releases/detail/35/cleveland-cliffs-completes-acquisition-of-ak-steel.)

CNBC Indonesia, 2020, 5 smelter HPAL pemasok bahan baku baterai beroperasi di 2023 [5 HPAL smelters suppliers of battery raw materials to operate in 2023]: Jakarta, Indonesia, CNBC Indonesia, October 28. (Accessed May 2, 2024, at https://www.cnbcindonesia.com/news/20201028162028-4-197792/5-smelter-hpal-pemasok-bahan-baku-baterai-beroperasi-di-2023.) [In Indonesian.]

Eramet S.A., 2020, First metal tapping at Weda Bay Nickel, a key milestone in a successful development: Paris, France, Eramet S.A. news release, April 30. (Accessed April 25, 2024, at https://www.eramet.com/en/news/2020/04/first-metal-tapping-at-weda-bay-nickel-a-key-milestone-in-a-successful-development-2/.)

Horsehead Holding Corp., 2015, Form 10–K—2015: U.S. Securities and Exchange Commission, 76 p. plus exhibits. (Accessed January 5, 2022, at https://www.sec.gov/Archives/edgar/data/1385544/000119312516725704/d236839d10k.htm#tx236839_11.)

International Nickel Study Group, 2020, World directory of nickel production: Lisbon, Portugal, International Nickel Study Group, 5 sections (A–E).

International Nickel Study Group, 2023, World nickel statistics—Yearbook: Lisbon, Portugal, International Nickel Study Group, v. 32, no. 12, November, 4 sections (A–D).

International Stainless Steel Forum, 2021, Stainless steel in figures 2020: Brussels, Belgium, International Stainless Steel Forum, 24 p. (Accessed January 7, 2022, at https://www.worldstainless.org/Files/issf/non-image-files/PDF/ISSF_Stainless_Steel_in_Figures_2021_English_public_version.pdf.)

London Metal Exchange Ltd., The, 2019, Nickel stocks: London, United Kingdom, The London Metal Exchange Ltd., December 31.

London Metal Exchange Ltd., The, 2020, Nickel stocks: London, United Kingdom, The London Metal Exchange Ltd., December 31.

London Metal Exchange Ltd., The, [undated], LME Nickel—Contract specifications: London, United Kingdom, The London Metal Exchange Ltd. (Accessed May 6, 2024, via https://www.lme.com/Metals/Non-ferrous/LME-Nickel/Contract-specifications.)

Lundin Mining Corp., 2020, Annual information form—For the year ended December 21, 2019: Toronto, Ontario, Canada, Lundin Mining Corp., March 27, 103 p. (Accessed April 12, 2024, at https://lundinmining.com/site/assets/files/7863/lmc_-_2019_aif_-_032720.pdf.)

Lundin Mining Corp., 2021, Lundin Mining fourth quarter and full year 2020 results: Toronto, Ontario, Canada, Lundin Mining Corp. news release, February 18, 6 p. (Accessed April 12, 2024, at https://lundinmining.com/site/assets/files/8297/lundin_mining_corporation_lundin_mining_fourth_quarter_and_full.pdf.)

McRae, M.E., 2021, Nickel: U.S. Geological Survey Mineral Commodity Summaries 2021, p. 112–113.

Missouri Cobalt, LLC, [undated], Our projects: St. Louis, MO, Missouri Cobalt, LLC. (Accessed August 31, 2022, at https://www.mocobalt.com/projects.)

Newbanks, Michele, 2019, AMG Vanadium to build in Muskingum: The Parkersburg News and Sentinel [Zanesville, OH], July 14. (Accessed February 18, 2022, at https://www.newsandsentinel.com/news/business/2019/07/amg-vanadium-to-build-in-muskingum/.)

Nickel Institute, [undated], Nickel in batteries: Toronto, Ontario, Canada, Nickel Institute. (Accessed May 8, 2024, at https://www.nickelinstitute.org/about-nickel/nickel-in-batteries.)

PJSC MMC Norilsk Nickel, 2020, Nornickel shuts down smelter in Nikel town: Moscow, Russia, PJSC MMC Norilsk Nickel news release, December 23. (Accessed April 26, 2024, at https://nornickel.com/news-and-media/press-releases-and-news/nornickel-shuts-down-smelter-in-nikel-town/?sources[0]=21.)

PolyMet Mining Corp., 2021, Annual information form for the year ended December 31, 2020: St. Paul, MN, PolyMet Mining Corp., March 18, 60 p. (Accessed April 12, 2024, at https://polymetmining.com/wp-content/uploads/2021/03/SEDAR-2020-AIF.pdf.)

PR Newswire, 2021, Missouri Cobalt nears completion of key facility, advancing its leadership goal in domestic battery-grade cobalt and nickel: PR Newswire, June 30. (Accessed April 15, 2024, at https://www.prnewswire.com/news-releases/missouri-cobalt-nears-completion-of-key-facility-advancing-its-leadership-goal-in-domestic-battery-grade-cobalt-and-nickel-301323342.html.)

Project Blue Group Ltd., 2024, Nickel market service—January 2024: London, United Kingdom, Project Blue Group Ltd. (Accessed August 30, 2023, via https://www.projectblue.com/.)

Ramaphosa, Cyril, 2020, President Cyril Ramaphosa—Extension of coronavirus COVID-19 lockdown to the end of April: Pretoria, South Africa, Government of South Africa press release, April 9. (Accessed April 30, 2024, at https://www.gov.za/news/speeches/president-cyril-ramaphosa-extension-coronavirus-covid-19-lockdown-end-april-09-apr.)

Roskill Information Services Ltd., 2021, Nickel—Outlook to 2030, 17th edition: London, United Kingdom, Roskill Information Services Ltd., 206 p.

Sibanye Gold Ltd., 2017, Sibanye successfully concludes the acquisition of Stillwater: Westonaria, South Africa, Sibanye Gold Ltd. press release, May 4. (Accessed February 16, 2021, at https://thevault.exchange/?get_group_doc=245/1493909905-sgl-sibanye-successfully-concludes-stillwater-acquisition-04may2017.pdf.)

South32 Ltd., 2021, Quarterly report December 2020: Perth, Western Australia, Australia, South32 Ltd. news release, January 20. (Accessed April 23, 2024, at https://www.south32.net/docs/default-source/exchange-releases/quarterly-report-december-2020.pdf?sfvrsn=ccc7880b_2.)

Stephan, B.J., 2013, Refining refiners spent catalysts: Craven Arms, United Kingdom, Digitalrefining.com, Crambeth Allen Publishing Ltd., March, 4 p. (Accessed January 5, 2022, at https://www.digitalrefining.com/article/1000782/refining-refiners-spent-catalysts#.XyiIHp5KhPY.)

Stillwater Mining Co., 2017, Form 10–K—2016: U.S. Securities and Exchange Commission, 108 p. (Accessed February 16, 2021, at https://www.sec.gov/Archives/edgar/data/931948/000093194817000012/swc-12312016x10k.htm.)

Terrafame Oy, 2020, Terrafame well positioned to supply for the greenest batteries on the planet: Sotkamo, Finland, Terrafame Oy news release, December 2. (Accessed May 2, 2024, at https://www.terrafame.com/newsroom/media-releases/terrafame-well-positioned-to-supply-for-the-greenest-batteries-on-the-planet.html?p461=10.)

Twin Metals Minnesota LLC, 2019, Mine plan of operations: St. Paul, MN, Twin Metals Minnesota LLC, December 18, 102 p. (Accessed February 17, 2022, via https://www.twin-metals.com/resource/twin-metals-minnesota-mine-plan-of-operations/.)

Twin Metals Minnesota LLC, 2020, U.S. Bureau of Land Management issues notice of intent to start scoping process for environmental impact statement on proposed Twin Metals Minnesota mine: St. Paul, MN, Twin Metals Minnesota LLC news release, June 30. (Accessed April 15, 2024, at https://www.twin-metals.com/press-release/u-s-bureau-of-land-management-issues-notice-of-intent-to-start-scoping-process-for-environmental-impact-statement-on-proposed-twin-metals-minnesota-mine/.)

U.S. Environmental Protection Agency, 2019, "Cobalt mine" in Fredericktown, Missouri, is focus of EPA Administrator and Rep. Jason Smith recognition event: Fredericktown, MO, U.S. Environmental Protection Agency news release, July 31. (Accessed March 3, 2022, at https://www.epa.gov/newsreleases/cobalt-mine-fredericktown-missouri-focus-epa-administrator-and-rep-jason-smith.)

U.S. Geological Survey, 2021, U.S. Geological Survey Mineral Commodity Summaries 2021: U.S. Geological Survey, 204 p.

U.S. Mint, [undated]a, Circulating coin production: Washington, DC, U.S. Mint. (Accessed May 6, 2024, via https://www.usmint.gov/about/production-sales-figures/circulating-coins-production.)

U.S. Mint, [undated]b, Coin specifications: Washington, DC, U.S. Mint. (Accessed May 6, 2024, at https://www.usmint.gov/learn/coin-and-medal-programs/coin-specifications.)

Vale S.A., 2021, Form 20–F—For the fiscal year ended December 31, 2020: U.S. Securities and Exchange Commission, 206 p. (Accessed May 2, 2024, at https://www.sec.gov/Archives/edgar/data/917851/000104746921000687/a2243060z20-f.htm.)

GENERAL SOURCES OF INFORMATION

U.S. Geological Survey Publications

Historical Statistics for Mineral and Material Commodities in the United States. Data Series 140.
Nickel. Ch. in Mineral Commodity Summaries, annual.
Nickel. Ch. in United States Mineral Resources, Professional Paper 820, 1973.
Nickel. International Strategic Minerals Inventory Summary Report, Circular 930–D, 1985.
Nickel. Mineral Industry Surveys, monthly.
Nickel (Ni). Ch. In Metal Prices in the United States Through 2010, Scientific Investigations Report 2012–5188, 2013.

Other

International Nickel Study Group (Lisbon, Portugal).
Nickel. Ch. in Mineral Facts and Problems, U.S. Bureau of Mines Bulletin 675, 1985.
Nickel Institute (Toronto).
Roskill Information Services Ltd.

TABLE 1
SALIENT NICKEL STATISTICS[1]

(Metric tons, nickel content, unless otherwise specified)

		2016	2017	2018	2019	2020
United States:						
Production, concentrate		24,100	22,100	17,600	13,500	16,700
Secondary recovery from purchased scrap:						
From ferrous scrap		89,000 r	83,000 r	72,200 r	109,000 r	97,100
From nonferrous scrap		5,790	5,740	5,690	4,240 r	4,050
Shipments of purchased scrap[2]		94,700 r	88,800 r	77,900 r	113,000 r, 3	101,000 3
Exports:						
Ores and concentrates[4]		22,400	20,000	18,000	14,300	13,400
Primary[5]		10,300	11,000	9,780	12,800	11,300
Secondary		63,700	51,500	59,400	47,800 r	34,100
Imports for consumption:						
Ores and concentrates[4]		(6)	64	3	4	95
Primary		111,000	150,000	144,000	119,000	105,000
Secondary		32,300	38,100	45,100	37,700	31,800
Consumption:						
Reported:						
Primary[5]		97,800	105,000	107,000	105,000	84,600
Secondary, purchased scrap		136,000 r	133,000	123,000	113,000 r	96,900
Total		234,000 r	237,000 r	230,000	218,000 r	182,000
Apparent, primary[5]		104,000	140,000	136,000	106,000	94,100
Apparent primary plus reported secondary[5]		240,000 r	273,000	259,000	219,000 r	191,000
Stocks, yearend:						
London Metal Exchange Ltd. (LME), U.S. warehouses		5,230	3,780	2,270	1,970	1,730
Consumer, primary[5]		6,370	6,550	6,780	6,860	7,210
Consumer, secondary		8,740 r	8,030 r	9,550 r	8,390 r	6,700
Total		20,300	18,400	18,600	17,200 r	15,600
Price:						
Cash, LME:						
Average annual	dollars per metric ton	9,594	10,403	13,114	13,903	13,772
Average annual	dollars per pound	4.352	4.719	5.948	5.384 r	6.25
Type 18-8 stainless steel scrap, gross weight:[7]						
Average annual	dollars per metric ton	941 r	1,086 r	1,129 r	1,149 r	1,193
Average annual	dollars per long ton	956 r	1,100 r	1,150 r	1,170 r	1,210
World, mine production[8]		2,000,000 r	2,190,000 r	2,380,000 r	2,590,000 r	2,510,000

rRevised.
[1]Table includes data available through January 31, 2022. Data are rounded to no more than three significant digits, except prices; may not add to totals shown.
[2]Defined as scrap receipts less shipments by consumers plus exports minus imports plus adjustments for consumer stock changes.
[3]Some data were withheld to avoid disclosing company proprietary data. Data are not included in total.
[4]Nickel ores and concentrates (Harmonized Tariff Schedule of the United States code 2604.00.0040). Source: U.S. Census Bureau.
[5]Primary nickel refers to a nickel product produced from the beneficiation and processing of mined ore that is ready for use in a downstream consuming industry.
[6]Less than ½ unit.
[7]Source: S&P Global Platts Metals Week.
[8]May include estimated data.

TABLE 2
NICKEL RECOVERED FROM PURCHASED SCRAP
IN THE UNITED STATES,
BY TYPE OF SCRAP AND FORM OF RECOVERY[1]

(Metric tons, nickel content)

	2019	2020
Type of scrap:		
Aluminum-base	2,120 r	1,780
Copper-base	W	W
Ferrous-base[2]	109,000 r	97,100
Nickel-base	2,120 r, 3	2,270 3
Total	113,000 r	101,000
Form of recovery:		
Aluminum-base alloys	2,120 r	1,780
Copper-base alloys	W	W
Ferrous-base alloys	109,000 r	97,100
Nickel-base alloys	2,120 r	2,270
Total	113,000 r	101,000

rRevised. W Withheld to avoid disclosing company proprietary data; not included in total.
[1]Table includes data available through January 31, 2022. Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Primarily stainless- and alloy-steel scrap consumed at steel mills and foundries.
[3]Includes copper-base, copper-nickel, and nickel-base scrap.

TABLE 3
REPORTED U.S. CONSUMPTION OF NICKEL, BY FORM[1]

(Metric tons, nickel content)

Form	2019	2020
Primary:[2]		
Metal	88,000	70,800
Ferronickel	13,200	11,700
Oxide and oxide sinter[3]	189	W
Other[4]	3,380	2,130
Total	105,000	84,600
Secondary, scrap[5]	113,000 r	101,000
Grand total	218,000 r	186,000

rRevised. W Withheld to avoid disclosing company proprietary data; not included in total.
[1]Table includes data available through January 31, 2022. Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Primary nickel refers to a nickel product produced from the beneficiation and processing of mined ore that is ready for use in a downstream consuming industry.
[3]Includes chemical-grade oxide.
[4]Includes base-master alloys, nickel salts, and other forms of nickel not included above.
[5]Based on gross weight of purchased scrap consumed and estimated average nickel content.

TABLE 4
REPORTED U.S. CONSUMPTION OF NICKEL, BY USE[1]

Use	2020			Grand total in 2019
	Total primary[2]	Secondary (scrap)	Grand total in 2020	
Chemicals and chemical uses[3]	1,020	--	1,020	1,020 r
Nickel alloys:				
Superalloys	22,100	W	22,100	31,700 r
Other[4]	13,500	W	13,500	21,600 r
Plating	7,180	--	7,180	7,260 r
Steel:				
Stainless and heat resistant	37,800	95,200	133,000	149,000 r
Alloys, excludes stainless	3,090	1,690	4,780	7,290 r
Total	84,600	96,900	182,000	218,000 r

rRevised. W Withheld to avoid disclosing company proprietary data; not included in total. -- Zero.
[1]Table includes data available through January 31, 2022. Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Primary nickel refers to a nickel product produced from the beneficiation and processing of mined ore that is ready for use in a downstream consuming industry.
[3]Includes batteries, catalysts, and ceramics.
[4]Includes cast iron; cemented carbides; coinage; copper-nickel and nickel-copper alloys; electrical, magnetic, expansion, and wear-resistant alloys; and powder alloys.

TABLE 5
NICKEL IN CONSUMER STOCKS IN THE UNITED STATES
BY FORM, DECEMBER 31[1]

(Metric tons, nickel content)

Form	2019	2020
Primary:[2]		
Metal	6,070	6,010
Ferronickel	322	W
Oxide and oxide sinter	50	W
Chemicals	W	W
Other	419	1,200
Total	6,860	7,210
Secondary, scrap	8,390 r	6,700
Grand total	15,200 r	13,900

rRevised. W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Table includes data available through January 31, 2022. Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Primary nickel refers to a nickel product produced from the beneficiation and processing of mined ore that is ready for use in a downstream consuming industry.

TABLE 6
U.S. EXPORTS OF NICKEL PRODUCTS, BY CLASS[1]

Class	2019		2020	
	Quantity (metric tons, nickel content)	Value (thousands)	Quantity (metric tons, nickel content)	Value (thousands)
Primary:[2]				
Unwrought:				
Cathodes, pellets, briquettes, shot	1,500 r	$22,100	1,580	$22,200
Ferronickel	12	334	24	897
Powder and flakes	1,490	61,800	1,380	57,800
Metallurgical-grade oxide[3]	1,030	18,600	604	7,940
Chemicals:				
Catalysts[4]	7,640	508,000 r	6,600	434,000
Salts[5]	1,150	17,900	1,080	17,600
Total	12,800	629,000 r	11,300	540,000
Secondary:				
Stainless-steel scrap	31,700 r	345,000 r	23,500	276,000
Waste and scrap[6]	16,100 r	135,000 r	10,500	79,900
Total	47,800 r	480,000 r	34,100	355,000
Grand total	60,600 r	1,110,000	45,400	895,000
Wrought, not alloyed:				
Bars, rods, profiles, wire	260	9,060	650	13,100
Sheets, strip, foil	337	9,910	184	6,850
Tubes and pipes	85	1,920	27	687
Total	682	20,900	861	20,700
Alloyed, gross weight:				
Unwrought alloyed ingot	7,030 r	236,000	6,560	154,000
Bars, rods, profiles, wire	27,800	915,000	19,200	631,000
Sheets, strip, foil	15,000	448,000	11,900	349,000
Tubes and pipes	2,110	261,000	1,720	182,000
Other alloyed articles	3,520	831,000	2,920	511,000
Total	55,400	2,690,000	42,300	1,830,000

rRevised.
[1]Table includes data available through July 15, 2021. Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Primary nickel refers to a nickel product produced from the beneficiation and processing of mined ore that is ready for use in a downstream consuming industry.
[3]Nickel content is assumed to be 77%.
[4]Typical catalyst is assumed to have a nickel content of 22%.
[5]Nickel contents are as follows: chemical-grade oxide, sesquioxide, and hydroxide, 65%; chlorides, 25%; sulfates, 22%; and other salts, assumed to be 22%.
[6]Waste and scrap content is assumed to be 50% nickel; stainless-steel scrap, 7.5%.

Source: U.S. Census Bureau.

TABLE 7
U.S. EXPORTS OF NICKEL PRODUCTS, BY COUNTRY OR LOCALITY[1]

(Metric tons, nickel content)[2]

	2020									
Country or locality[3]	Cathodes, pellets, and briquettes (unwrought)	Powder and flakes	Ferronickel	Metallurgical-grade oxide[4]	Waste and scrap	Stainless-steel scrap	Chemicals	Total in 2020	Total in 2019	Wrought nickel in 2020[5]
Argentina	--	21	--	--	--	4	64	89	122	--
Australia	1	3	7	--	700	2	(6)	712	1,260	(6)
Belgium	--	4	--	--	47	89	660	800	710	--
Brazil	--	53	--	(6)	--	3	161	217	237	3
Canada	186	130	1	409	6,810	2,760	1,220	11,500	15,500 r	9
China	26	230	5	15	--	18	960	1,250	846	48
Denmark	--	1	--	--	--	3	322	326	346	--
Finland	--	--	--	--	--	8	397	404	568	(6)
Germany	--	280	--	4	172	53	341	849	879	44
Hong Kong	--	9	--	46	--	214	4	273	210	9
India	--	40	12	(6)	323	9,070	221	9,660	11,800	29
Indonesia	--	(6)	--	19	--	500	79	598	243	--
Italy	--	12	--	18	70	16	81	197	331	114
Japan	57	99	--	1	803	380	359	1,700	1,720	(6)
Korea, Republic of	(6)	70	(6)	(6)	30	435	1,020	1,560	1,510	2
Kuwait	--	--	--	--	--	(6)	156	156	1,470	(6)
Malaysia	--	(6)	--	--	2	429	6	437	933	(6)
Mexico	1,120	82	--	3	24	2,690	116	4,030	4,070	370
Netherlands	--	5	--	--	288	50	27	370	426	1
Pakistan	--	1	--	--	3	1,530	2	1,540	1,950	--
Russia	--	5	--	--	--	--	133	138	114	--
Saudi Arabia	--	1	--	--	--	2	78	81	342	3
Singapore	(6)	141	--	3	11	1	29	185	393	24
Spain	--	5	--	--	82	42	1	130	320	6
Sweden	(6)	37	--	--	237	47	5	326	821	10
Taiwan	5	15	--	--	89	4,530	360	4,990	9,520	7
Thailand	--	35	--	--	--	456	35	527	723	3
Turkey	36	14	--	--	--	5	(6)	55	258	(6)
United Arab Emirates	136	2	--	--	--	11	27	176	172	1
United Kingdom	--	35	(6)	58	764	20	65	943	1,370	4
Vietnam	--	4	--	--	--	9	176	190	645	7
Other[7]	13	51	(6)	29	80	174	583	930	833	42
Total	1,580	1,380	24	604	10,500	23,500	7,690	45,400	60,600 r	735

See footnotes at end of table.

TABLE 7—Continued
U.S. EXPORTS OF NICKEL PRODUCTS, BY COUNTRY OR LOCALITY[1]

[r]Revised. -- Zero.
[1]Table includes data available through July 15, 2021. Data are rounded to no more than three significant digits; may not add to totals shown.
[2]The nickel contents are assumed to be as follows: metallurgical-grade oxide, 77%; waste and scrap, 50%; and stainless-steel scrap, 7.5%. The "Chemicals" category contains the following: chemical-grade oxide, sesquioxide, and hydroxide, 65% nickel; chlorides, 25% nickel; sulfates, 22% nickel; and other salts and various catalysts are assumed to be 22% nickel.
[3]Countries and (or) localities listed were the leading export recipients in 2020 in terms of quantity (nickel content).
[4]Chemical-grade oxide is included in the "Chemicals" category.
[5]Not included in total in 2020.
[6]Less than ½ unit.
[7]Includes 75 countries and (or) localities with less than 100 metric tons total in 2020.

Source: U.S. Census Bureau.

TABLE 8
U.S. IMPORTS FOR CONSUMPTION OF NICKEL PRODUCTS, BY CLASS[1]

Class	2019		2020	
	Quantity (metric tons, nickel content)	Value (thousands)	Quantity (metric tons, nickel content)	Value (thousands)
Primary:[2]				
Unwrought:				
Cathodes, pellets, briquettes, shot	97,400	$1,350,000	87,500	$1,200,000
Ferronickel	11,900	153,000	11,200	145,000
Powder and flakes	6,370	129,000	3,830	83,300
Metallurgical-grade oxide[3]	237	4,530	412	7,550
Chemicals:				
Catalysts[4]	2,190 r	95,800 r	1,820	75,900
Salts[5]	876	17,400	665	12,700
Total	119,000	1,750,000	105,000	1,520,000
Secondary:				
Stainless-steel scrap	15,300	183,000	16,500	197,000
Waste and scrap[6]	22,400	328,000	15,300	180,000
Total	37,700	510,000	31,800	377,000
Grand total	157,000	2,260,000	137,000	1,900,000
Wrought, not alloyed:				
Bars, rods, profiles, wire	113 r	2,790 r	304	5,080
Sheets, strip, foil	585	13,900	524	13,500
Tubes and pipes	450 r	25,100 r	327	14,400
Total	1,150 r	41,700 r	1,160	33,000
Alloyed, gross weight:				
Unwrought alloyed ingot	5,370 r	94,000 r	3,430	54,400
Bars, rods, profiles, wire	14,300 r	366,000 r	11,800	306,000
Sheets, strip, foil	5,440	121,000	3,530	90,800
Tubes and pipes	3,220 r	192,000 r	2,360	166,000
Other alloyed articles	8,020 r	387,000 r	5,120	280,000
Total	36,400 r	1,160,000	26,300	897,000

rRevised.
[1]Table includes data available through July 27, 2021. Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Primary nickel refers to a nickel product produced from the beneficiation and processing of mined ore that is ready for use in a downstream consuming industry.
[3]Nickel content from Australia, 90%; elsewhere, 77%.
[4]Typical catalyst is assumed to have a nickel content of 22%.
[5]Nickel contents are as follows: chemical-grade oxide, sesquioxide, and hydroxide, 65%; chlorides, 25%; sulfates, 22%; and other salts, assumed to be 22%. Excludes nickel carbonate.
[6]Waste and scrap is assumed to be 50% nickel; stainless-steel scrap, 7.5%.

Source: U.S. Census Bureau.

TABLE 9
U.S. IMPORTS FOR CONSUMPTION OF NICKEL PRODUCTS, BY COUNTRY OR LOCALITY[1]

(Metric tons, nickel content)[2]

	2020									
Country or locality[3]	Cathodes, pellets, and briquettes (unwrought)	Powder and flakes	Ferronickel	Metallurgical-grade oxide[4]	Waste and scrap	Stainless-steel scrap	Chemicals	Total in 2020	Total in 2019	Wrought nickel in 2020[5]
Australia	4,710	290	--	--	332	--	--	5,330	7,000	(6)
Belgium	--	36	--	--	11	1	217	264	397	3
Brazil	--	--	6,130	--	49	8	--	6,190	5,720	(6)
Canada	54,900	2,320	--	--	4,370	9,060	162	70,800	69,600	114
China	--	17	2	380	436	6	82	924	722 r	84
Denmark	--	--	--	--	--	1	420	421	453	(6)
Dominican Republic	20	--	1,790	--	--	22	--	1,830	2,230	--
Estonia	--	--	--	--	139	54	--	194	--	--
Finland	7,790	309	--	--	47	--	45	8,190	13,100	--
France	--	12	--	--	336	5	260	613	1,520	168
Germany	20	106	--	--	539	(6)	166	832	1,450	434
Guatemala	--	--	359	--	--	7	--	365	770	--
India	--	--	--	(6)	28	1	294	323	395	45
Italy	23	5	1	--	159	(6)	32	220	544	16
Japan	1,410	2	--	--	1,160	24	267	2,870	5,070	3
Korea, Republic of	--	(6)	--	5	156	1	27	190	347	15
Macedonia	--	--	792	--	--	--	--	792	--	--
Madagascar	--	--	--	--	--	--	--	--	889	--
Mexico	--	--	--	--	1,250	6,580	--	7,830	9,030	147
Netherlands	--	3	--	--	174	367	88	633	309	2
New Caledonia	--	--	2,110	--	11	--	--	2,120	3,000	--
Norway	9,200	--	--	--	30	--	--	9,230	8,640	(6)
Philippines	--	--	--	--	10	--	103	113	104	--
Russia	6,000	193	--	--	1,910	59	--	8,160	13,200	--
Saudi Arabia	--	--	--	--	238	--	139	377	491	--
Singapore	--	--	--	--	438	--	--	438	933	(6)
South Africa	1,910	158	--	--	--	--	--	2,070	2,610	--
Spain	--	1	--	--	181	(6)	--	182	402	1
Switzerland	--	--	--	--	51	--	--	51	141	(6)
Taiwan	--	--	--	--	117	24	25	166	304	5
Turkey	--	--	--	--	106	--	--	106	265	1
United Kingdom	1,490	376	2	18	2,670	8	93	4,660	6,510	40
Other[7]	--	7	58	8	335	234	67	710	663	77
Total	87,500	3,840	11,200	412	15,300	16,500	2,490	137,000	157,000	1,160

See footnotes at end of table.

TABLE 9—Continued

U.S. IMPORTS FOR CONSUMPTION OF NICKEL PRODUCTS, BY COUNTRY OR LOCALITY[1]

[r]Revised. -- Zero.

[1]Table includes data available through August 9, 2021. Data are rounded to no more than three significant digits; may not add to totals shown.

[2]The nickel contents are assumed to be as follows: metallurgical-grade oxide from Australia, 90%; elsewhere, 77%. The "Chemicals" category contains the following: chemical-grade oxide, sesquioxide, and hydroxide, 65% nickel; chlorides, 25% nickel; sulfates, 22% nickel; and other salts and various catalysts are assumed to be 22% nickel. Waste and scrap is assumed to be 50% nickel; stainless-steel scrap, 7.5% nickel.

[3]Countries and (or) localities listed were the leading suppliers to the United States in 2020 in terms of quantity (nickel content).

[4]Primarily oxide, rondelles, and sinter.

[5]Not included in total in 2020.

[6]Less than ½ unit.

[7]Includes 46 countries and (or) localities with less than 100 metric tons each in 2020.

Source: U.S. Census Bureau.

TABLE 10

NICKEL: WORLD MINE PRODUCTION, BY COUNTRY OR LOCALITY[1, 2]

(Metric tons, nickel content)

Country or locality[3]	2016	2017	2018	2019	2020
Albania, laterite ore	3,952	4,939	4,204	2,830	3,200 e
Australia, undifferentiated or other	203,135	185,466	160,022	158,751	169,344
Botswana, sulfide ore, matte produced	14,273	--	--	--	--
Brazil, undifferentiated or other	78,626 r	68,803 r	65,254 r	55,744 r	77,133
Burma, laterite ore	20,000	20,000	21,000	20,000	22,200
Canada, sulfide ore, concentrate	230,210	206,354	177,867	181,410	167,243
China, undifferentiated or other	100,200	102,300	108,200 r	120,000 e	120,000 e
Colombia, laterite ore, dry	41,082	45,510	47,700	45,000	38,700
Cuba, laterite ore	51,600	52,800	52,200	48,900 r	48,000
Dominican Republic, laterite ore[e]	19,900	28,300	34,700	51,700 r	40,000
Finland, undifferentiated or other	20,654	34,641	43,572	38,530	41,429
Greece, laterite ore	19,431	19,073	17,925	13,655	7,040
Guatemala, laterite ore	45,900	53,700	39,200	36,300	55,400
Indonesia, laterite ore	204,000	355,000	606,000	853,000	771,000
Kosovo, laterite ore[e]	4,270	7,120	4,790	3,310	3,960
Madagascar, laterite ore, nickel-cobalt sulfide[4]	49,000 e	42,000 e	39,000 e	39,000 e	10,800
Morocco, undifferentiated or other	188	196	126	131 r	142
New Caledonia, laterite ore	204,207	215,382	216,225	208,185	199,697
Norway, undifferentiated or other	220	206	210	200	200
Papua New Guinea, laterite ore, nickel-cobalt hydroxide[5]	22,269	34,666	35,355	32,720	33,659
Philippines, laterite ore	300,506	339,377	344,966	323,325	333,962
Russia:					
Laterite ore	7,000 e	1,800 e	--	--	--
Sulfide ore, concentrate	252,000	266,000	272,000 r	279,000 r	283,000
South Africa, sulfide ore, concentrate	48,994	48,463 r	43,236	43,466 r	34,908
Turkey, laterite ore	10,680	17,000	13,600 r	4,800 r	13,200
United States, sulfide ore, concentrate	24,100	22,100	17,600	13,500	16,700
Vietnam, sulfide ore, concentrate	4,272	--	--	--	--
Zambia, concentrate	--	--	--	-- r	3,200
Zimbabwe, sulfide ore, concentrate	17,743	16,617	17,850	16,593	16,336
Total	2,000,000 r	2,190,000 r	2,380,000 r	2,590,000 r	2,510,000
Of which:					
Laterite ore	1,000,000	1,240,000	1,480,000	1,680,000 r	1,580,000
Sulfide ore	591,000 r	559,000	529,000	534,000 r	518,000
Undifferentiated or other	403,000 r	392,000 r	377,000 r	373,000 r	411,000

[e]Estimated. [r]Revised. -- Zero.

[1]Table includes data available through November 17, 2021. All data are reported unless otherwise noted; totals may include estimated data. Totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.

[2]Insofar as possible, this table represents recoverable mine production of nickel. Where actual mine output was not available, reported data represent a more highly processed form to provide an indication of the magnitude of mine output.

[3]In addition to the countries and (or) localities listed, North Korea may have produced nickel, but available information was inadequate to make reliable estimates of output.

[4]Often called mixed sulfide product or MSP.

[5]Often called mixed hydroxide product or MHP.

TABLE 11

NICKEL: WORLD PRODUCTION OF INTERMEDIATE PRODUCTS FOR EXPORT, BY COUNTRY OR LOCALITY[1, 2]

(Metric tons, nickel content)

Country or locality	2016	2017	2018	2019	2020
Matte:					
Australia	38,247	36,812	11,400	16,900	21,190
Botswana	14,273	--	--	--	--
Canada[e, 3]	90,800	65,200	57,200	51,200	42,200
Finland	31,000 [r]	25,000	31,000	26,000 [r]	25,000
Indonesia[4]	77,581	76,807	74,806	71,025	72,237
New Caledonia	4,287	--	--	--	--
Russia[e, 5]	16,900	42,700	43,900	53,500	48,400
Zimbabwe[6]	5,346	4,705	5,187	4,933	5,028
Total	278,000 [r]	251,000	224,000	224,000 [r]	214,000
Other:					
Cuba:[e]					
Ammoniacal liquor precipitate and unspecified	1,800	1,800	1,300	1,000 [r]	1,000
Nickel-cobalt sulfide[7]	34,800	35,200	34,800	37,000	35,000
New Caledonia, nickel-cobalt hydroxide[8]	7,269	6,525	6,723	6,483	18,253
Papua New Guinea, nickel-cobalt hydroxide[8]	22,269	34,666	35,355	32,720	33,659
Philippines, nickel-cobalt sulfide[7]	48,371	50,553	48,633	51,144	49,647
Turkey, nickel-cobalt hydroxide[8]	1,790	4,000	5,001	2,175	4,723
Total	116,000	133,000	132,000	131,000	142,000
Grand total	395,000 [r]	384,000	355,000	354,000 [r]	356,000

[e]Estimated. [r]Revised. -- Zero.

[1]Table includes data available through February 3, 2022. All data are reported unless otherwise noted; totals may include estimated data. Totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.

[2]Data represent nickel content of matte and other intermediate materials produced.

[3]Nickel content of matte and metallurgical-grade nickel oxide as reported by the Global Trade Atlas using Harmonized System number 7501. According to the International Nickel Study Group, the nickel content of matte was 50% and the nickel content of metallurgical-grade oxide was 75.2%.

[4]Represents the nickel output of the Soroako smelter. The Soroako matte was shipped to Japan for further processing and contained on average 78% nickel.

[5]Nickel content of matte, primarily exported to Finland, as reported by the Global Trade Atlas using Harmonized System number 7501, with an estimated 40% nickel content.

[6]Zimplats matte shipped to the Impala Refinery at Springs, South Africa.

[7]Often called mixed sulfide product or MSP.

[8]Often called mixed hydroxide product or MHP.

TABLE 12
NICKEL: WORLD PRIMARY PRODUCTION, BY COUNTRY OR LOCALITY AND PRODUCT[1, 2]

(Metric tons, nickel content)

Country or locality[3]	2016	2017	2018	2019	2020
Australia:					
Metal	117,920	108,500	114,517	106,470	115,800
Unspecified[4]	2,600	--	--	--	--
Total	120,520	108,500	114,517	106,470	115,800
Austria, ferronickel	1,000	1,000	1,000	1,000	900
Brazil, ferronickel	74,749 r	68,803	65,254	54,221	58,911
Burma, ferronickel	16,800	16,200	15,900 e	15,500	21,300 e
Canada, unspecified	158,299	154,759	137,411	124,736	124,043
China:					
Chemicals	29,100	39,900	45,200	41,300	64,000
Ferronickel, nickel pig iron	374,745	411,462	476,040	600,340	505,000
Metal	221,700	202,900	191,100	185,115 r	175,000
Total	625,545	654,262	712,340	826,755 r	744,000
Colombia, ferronickel	37,085 r	40,599 r	43,048 r	40,564 r	36,094
Cuba, oxide sinter, including oxides[5]	15,006	15,751	14,670	12,900 r	12,000 e
Dominican Republic, ferronickel	9,913	15,632	19,214	28,450	22,005
Finland:					
Chemicals, including powder, salts, solutions, other	8,048	8,358	10,330	10,608	10,800 e
Metal, electrolytic, including cathode and briquettes	45,606	51,342	50,435	51,792	52,600 e
Total	53,654	59,700	60,765	62,400	63,400 e
France:[6]					
Chemicals	3,122	1,385	1,797	2,031	1,323
Metal, cathode	1,513	546	1,913	4,946	6,032
Total	4,635	1,931	3,710	6,977	7,355
Greece, ferronickel	17,071	16,781	15,720	11,974	6,012
Guatemala, ferronickel	8,688	12,416	14,688	20,323	22,894
Indonesia:					
Ferronickel	20,293	21,762	24,868	25,713	25,970
Ferronickel, nickel pig iron[e]	75,900	74,800	73,300	179,000	307,000
Total	96,200	96,600	98,200	205,000	333,000
Japan:					
Chemicals	11,153	16,773	15,624	16,132	17,400 e
Ferronickel	61,700	57,800	62,900	62,500 r	63,000 e
Metal	63,132	61,377	57,517	58,778 r	55,368
Oxide sinter	55,500	51,100	50,700	45,000 r	45,000 e
Total	191,485 r	187,050 r	186,741 r	182,410 r	180,768
Korea, Republic of, ferronickel	45,600	47,400	45,631	46,000	46,000 e
Kosovo, ferronickel	2,540	7,100	5,700	6,000 r	5,000
Macedonia, ferronickel	10,603	7,175	10,100	15,202	17,747
Madagascar, metal	42,105	35,474	33,183	33,733	9,874
Morocco, chemicals, nickel hydroxide	188	196	126	131 r	142
New Caledonia:					
Ferronickel	67,518	73,219	82,114	70,654	65,051
Oxide sinter	28,465	30,875	25,800	17,267	7,404
Total	95,983	104,094	107,914	87,921	72,455
Norway, metal	92,700	86,500	90,800	92,100	91,100
Russia:					
Chemicals	2,400 e	--	--	--	--
Metal	188,700	157,396	158,005	166,265	172,357
Total	191,100 r	157,396	158,005	166,265	172,357
South Africa:					
Chemicals[7]	4,743	4,966	5,281	5,000 r, e	4,800 e
Metal	42,332	42,362	39,500	37,184 r	27,618
Total	47,075	47,328	44,781	42,184 r	32,418
Ukraine, ferronickel[8]	18,100	15,300	15,807	14,200	14,719

See footnotes at end of table.

TABLE 12—Continued

NICKEL: WORLD PRIMARY PRODUCTION, BY COUNTRY OR LOCALITY AND PRODUCT[1, 2]

Country or locality[3]	2016	2017	2018	2019	2020
United Kingdom, metal	45,194	38,052	41,220	39,632 r	40,000 e
Grand total	2,020,000	2,000,000	2,060,000	2,240,000	2,250,000
Of which:					
Chemicals	58,800 r	71,600 r	78,400 r	75,200 r	98,500
Ferronickel	842,000 r	887,000	971,000	1,190,000	1,220,000
Metal	861,000 r	784,000	778,000 r	776,000 r	746,000
Oxide sinter	99,000	97,700	91,200	75,200 r	64,400
Unspecified	161,000 r	155,000 r	137,000 r	125,000 r	124,000

[e]Estimated. [r]Revised. -- Zero.

[1]Table includes data available through February 3, 2022. All data are reported unless otherwise noted; totals may include estimated data. Grand totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.

[2]Primary nickel refers to a nickel product ready for use by downstream consuming industries such as nickel chemicals and salts, ferronickel, nickel metal in various forms, nickel oxide sinter, and nickel pig iron. The U.S. Geological Survey does not use the terms Class I and Class II nickel as defined by the International Nickel Study Group (INSG). However, nickel metal reported here is generally equivalent to Class I nickel which is defined by the INSG as nickel with a minimum nickel content of 99% in the form of briquettes, cathodes (electrolytic nickel), flakes or powders, granules, pellets, and rondelles. Ferronickel, nickel oxide sinter, and nickel pig iron are classified by the INSG as Class II. Chemicals, although typically produced at refineries, are differentiated from production of metal when feasible. Several countries produced nickel-containing matte and other intermediates, but output of nickel in such materials has been excluded from this table to avoid double counting. Countries and (or) localities that produced intermediate products for export are listed in table 11.

[3]In addition to the countries and (or) localities listed, North Korea was thought to have produced metallic nickel and (or) ferronickel, but information was inadequate to make reliable estimates of output. Several countries and (or) localities produced nickel-containing matte, but output of nickel in such materials has been excluded from this table to avoid double counting. Countries and (or) localities that produced matte for export are listed in table 11.

[4]Products with a nickel content of less than 99%. Includes ferronickel, nickel oxides and oxide sinter and excludes intermediate nickel-cobalt sulfide matte, regulus, and speiss for further refining.

[5]Includes cobalt content of nickel oxide and oxide sinter.

[6]Includes metal and nickel chloride.

[7]Primarily in the form of crystalline nickel sulfate.

[8]May include nickel in remelt alloys derived from scrap.