

KBR Ammonia Plant Revamp Project Experience



KBR's experience in ammonia plant revamps includes 200 projects. The objective of revamps has most often been to increase the plant capacity and/or to reduce the energy consumption.

A revamp project involves modifications to selected areas of the plant. Typical items for modifications are the primary reformer, the carbon dioxide removal system, the compressor internals and the synthesis converter. The modifications reflect any improvements in the state of the art (this sentence does not make sense. For example, in several projects, we added KBR's proprietary reforming exchanger KRES™ resulting in substantial increase in ammonia production. We have also modified conventional plants to Purifier™ plants to, both, save energy and increase capacity.

A revamp project is always preceded by a study to define the scope of the revamp. The study includes estimates of the cost and benefits of the proposed revamp. (See our separate experience list for revamp studies.)

KBR has successfully executed revamp projects and achieved proven performance ability in plants originally designed by us or by other licensors all over the world. We have done it repeatedly, and we have extensive data on the results of previous revamps. We also draw on our experience from licensing more than 248 grassroot ammonia plants globally. KBR has successfully revamped key equipment including primary reformer furnace, waste heat boilers, converters, and baskets of original design or by other licensors.

Following is a list of some of the ammonia plant revamps performed by KBR since 1990. We have identified the capacity increase projects by quoting the revamped capacity. KBR revamp projects performed as standalone proprietary equipment (PEQ), e.g., reformer furnace, converters, boiler, unitized chiller are identified. Revamp of non-KBR base plants is highlighted by [*] in KBR scope column.

| Company/Location | Description of Revamp | Capacity MTPD | KBR Scope of Work | Year on Line |
|------------------------------------|-------------------------------------|------------------------|-------------------|--------------|
| Dakota Gasification (DGC), USA | Feed change | 1100 STPD | B | Ongoing |
| Acron AM2, Novgorod, Russia | Capacity increase and energy saving | 1750 MTPD to 2300 MTPD | B + PEQ | Ongoing |
| Acron AM3, Novgorod, Russia | Capacity increase and energy saving | 1750MTPD to 2300 MTPD | B + PEQ | Ongoing |
| PLNL, Point Lisas, Trinidad | Energy savings study | 1850 MTPD | B | Ongoing |
| CF Woodward, OK, USA | Whole plant | 1320 STPD to 1500 STPD | B, E | Ongoing |
| Nutrien, Fort Saskatchewan, Canada | Furnace and whole plant | 1300 MTPD to 1500 MTPD | B, PEQ | Ongoing |
| KRIBHCO India LBED | Furnace and whole plant revamp | 1890 MTPD X 2 | LBED | Ongoing |
| Petrokemija, Croatia | Ammonia recovery unit | 1360 MTPD | LBED | 2018 |
| Fertial, Annaba, Algeria | Synloop converter basket & 123-C | 1500 MTPD | E, L, a PEQ | Ongoing |
| Fertial, Arzoo, Algeria | Synloop converter basket & 123-C | 1500 MTPD | E, L, a PEQ | 2019 |
| Nutrien, Geismar, USA | Waste heat boiler upgrade | 1750 STPD | E, a, PEQ | 2019 |

| | | | | |
|------------------------------|---|-----------------------|-------------|------------------|
| Yara/BP Hull Basket | Ammonia converter basket | 850 MTPD | E, a, PEQ | 2018 |
| RCF, Trombay V, India | Energy saving | 1070 MTPD | BED | 2019 |
| Acron, Dorogobuzh, Russia | Capacity increase and energy saving | 2100 MTPD | BED, PEQ | 2019 |
| SAFCO IBB, Al-Jubail, KSA | Capacity increase and energy saving | 1650 MTPD | eB, FEED | 2019 |
| SPIC, Tuticorin, India | Capacity increase and energy saving | 1300 MTPD | B, PEQ [*] | Ongoing |
| MCF, Manglore, India | Capacity increase and energy saving | 880 MTPD | B, PEQ [*] | Ongoing |
| Green Dome Co, UAE | Capacity increase, relocation | 1650 MTPD | eB, FEED | Ongoing |
| Agrium, Fort S., Canada | Replacement ammonia converter | 1285 MTPD | E, PEQ | 2019 |
| Nutrien, Trinidad | HTS Exit WHB | 1600 MTPD | E, PEQ | Ongoing |
| KFCL, Kanpur, India | Integrated ammonia/urea energy saving | 1300 MTPD | B [*] | Ongoing |
| CFI, Woodward, OK, USA | Engineering of critical heat exchangers | 1500 STPD | E Pa [*] | 2016 |
| Koch Brandon, Canada | Furnace convection section | 1200 MTPD | E | 2016 |
| YPF, Barrup, Australia | Replacement ammonia converter basket | 2200 MTPD | PEQ | Ongoing |
| Nutrien, Augusta, USA | Purifier based capacity & energy gain | 2500 STPD | Early Work | 2016 |
| Petrokemija, Kutina, Croatia | High pressure condensate Stripping | – | B | 2018 |
| SABIC, SAFCO-III, KSA | Capacity increase and energy saving revamp, | 1800 MTPD | eB, FEED | In EPC |
| SAFCO-IBB, KSA | Furnace reharp, Aux boiler, transfer line | 1600 MTPD | E | 2016 |
| PCS Geismar, USA | Synthesis loop retrofit (brownfield) | 2150 STPD | eB | Ongoing |
| Koch Enid, USA | Reformer furnace radiant section | 1100 MTPD | E | 2016 |
| Koch, Beatrice, USA | Reformer furnace reharp & conv section | 1100 MTPD | E | 2016 |
| Koch Ft. Dodge, USA | Reformer convection section revamp | 1100 MTPD | E | 2016 |
| TOAZ, Togliatti, Russia | Capacity increase & energy reduction, seven | Incrémental 2200 MTPD | B, FEED [*] | Ongoing |
| PCS Trinidad, plant 1 & 2 | Furnace reharp & transfer line | 1600 MTPDx2 | E/PEQ | 2017 |
| PCS Geismar, USA | Capacity increase - reforming exchanger | 1600-2600 ST | eB, a, PEQ | Ongoing rescoped |

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| Mosaic, USA | Capacity increase & energy saving | 1450-1800 ST | B, E, a | Ongoing |
| Fertial Annaba, Algeria | Capacity increase & energy saving | 1000 to 1500 | B, E, a, PEQ | Ongoing in FEED |
| Fertial, Arzew, Algeria | Capacity increase & energy saving | 1000 to 1500 | B, E, a, PEQ | Ongoing in FEED |
| Qatar Fertilizer Company (QAFCO) Ammonia 1&2 | Capacity increase & energy saving- reforming | 1150 to 1650 total 3300 | FEED, a, PEQ [*] | Delivered 2016 |
| Fatima Fertilizer, Pakistan | Purifier cold box supply | 1800 | E, PEQ | 2015 |
| Nitrogenmuvek, Hungary | Capacity & energy - reforming exchanger | 1175 to 1650 | B+PEQ | 2016 |
| SAFCO-IBB, KSA | Ammonia converter basket retrofit | 1600 | E+PEQ | 2015 |
| PCS N2, Lima, OH, USA | Capacity increase – reforming exchanger | 1680 to 2140 | B+E+ PEQ [*] | Online 2015 |
| Agrium, Borger, TX, USA | Capacity increase, including furnace, RG | 1300 to 1725 | B+ EPC+ PEQ | In construction |
| Honeywell, Virginia, USA | Reformer furnace reharp | 1900 STPD | E+PEQ | 2014 |
| Zuari, Goa, India | Capacity increase | 850 to 1100 | B [*] | Partly 2016 |
| 1st Global, Baiji, Iraq | Capacity increase | 1000 to 1200 | B | suspended |
| SABIC, Al Bayroni, KSA | Energy saving | 1270 | B | completed |
| CNC, Trinidad | Capacity increase | 1850 to 2200 | E | 2015 |
| Huajin, Kuche, China | Capacity increase | 1,000 to 1,500 | B [*] | 2015 |
| NFL, Nangal, India | Energy saving using Purifier | 950 | B [*] | 2014 |
| PakArab, Multan, Pakistan | Capacity & energy - reform exchanger | 960 to 1400 | B | Delivered 2012 |
| KRIBHCO #1, Hazira, India | Capacity & energy using Purifier | 1360 to 1890 | B | 2012 |
| KRIBHCO #2, Hazira, India | Capacity & energy using Purifier | 1360 to 1890 | B | 2012 |
| Sabic, Al Bayroni, KSA | Primary reformer convection section | 1270 | B | 2011 |
| Sabic, Al Bayroni, KSA | Primary reformer auxiliary boiler | 1270 | B | 2011 |
| Fatima, Pakistan | Relocate plant from Holland | 1500 | B | 2011 |
| Zuari, Goa, India | Switch from naphtha to gas feed | 750 to 1050 | B [*] | 2011 |
| Yara, Tertre, Belgium | Primary reformer rebuild | 908 | E | 2009 |

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| Chambal #1, India | Capacity & energy - reform exchanger | 1600 to 2000 | B, Pa [*] | 2009 |
| Chambal 2, India | Capacity & energy – reform exchanger | 1520 to 1940 | B, Pa | 2010 |
| Daqing, China | Capacity increase | 1,000 to 1,500 | B, Pa, Ca | 2006 |
| Lutianhua, China | Capacity increase & energy decrease | 1,000 to 1,500 | B, Pa, Ca | 2005 |
| DSM, Galeen, Netherland | Ammonia converter basket retrofit | 1500 | Ea | 2007 |
| Shenzhen Liaohe Tongdo Chemicals, Liaoning, China | KRES retrofit & energy decrease | 1,070 | B, Pa | 2003 |
| Yuntianhua Group, China | Capacity increase & energy decrease | 1,000 to 1,500 | B, Pa, Ca | 2002 |
| PIM, Aceh, Indonesia | Radiant re-harp of primary reformer | 1,400 | E, Pa | 2001 |
| NCFC, Saudi Arabia | Capacity increase | 1,500 to 1,750 | B | 2000 |
| Kaltim, Bontang, Indonesia | Reformer revamp | | E, P Ca | 2000 |
| Simplot Canada, Brandon, Manitoba, Canada | Reformer turnaround assistance | | E, Pa, Ca | 2000 |
| PECOSA Cosoleacaque, Mexico | Radiant re-harp, BFW coil addition | 4 x 1,450 | E, Pa, Ca | 1999 |
| Terra Nitrogen, Unit 1 Verdigris, OK, US | Feed pre-heat coil replacement | | E | 1999 |
| PCS N2, Geismar, LA, US. | Radiant re-harp and convection mods | 1,630 | E, Pa, Ca | 1999 |
| IMC-Agrico, St. James, LA, US. | Convection section modification and auxiliary | 1,520 | E, Pa | 1998 |
| Agrium Carseland, AB, Canada | Convection section replacement | 1,800 | E, Pa, Ca | 1998 |
| HIP Azotara Pancevo, Serbia | Radiant re-harp | 1000 | E | 1998 |
| PECOSA Cosoleacaque, Mexico | Energy savings, capacity increase | 4 x 1,360 to 1450 | B, bid book | 1997 |
| CF Industries Donaldsonville, LA, US | Revamp of four plants | 910 to 1,475 | B | 1997 |
| Yara, Trinidad | Capacity increase | 680 to 880 | E, P, Cm | 1997 |
| C.F. Industries Donaldsonville, LA, US | Reformer revamp | 2 x 1,630 | E, Pa, Ca | 1997 |
| Agrium Fort Saskatchewan, AB, Canada | Emergency radiant re-harp | 1100 | E, Pa | 1997 |
| C.F. Industries Donaldsonville, LA, US. | Reformer revamp | 2 x 1,540 | E, Pa, Ca | 1997 |

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| Fertiberia Huelva, Spain | Radiant reharp | 1,400 | E, Pa, Ca | 1997 |
| Yara, Sluiskil, The Netherlands | Capacity increase & reduced energy | 910 to 1,100 | E, P, Cm | 1996 |
| PCS N2, Augusta, GA, US | Capacity increase | 1,360 to 1,800 | E | 1996 |
| P. T. Pupuk Kalimantan Timur, Bontang, Indonesia | Capacity increase | | E, Pa, Ca | 1996 |
| Incitec, Morningside, Queensland, Australia | Capacity increase, energy reduction, KAAP converter | 587 to 800 | B, P | 1996 |
| AMPRO Fertilizer Inc Donaldsonville, LA, US | Capacity increase, energy reduction, KAAP converter | | E, P, C | 1996 |
| Sherritt Inc. Ft. Saskatchewan, Alberta, | Condensate stripper | | E | 1996 |
| PCS N2, Memphis, TN, US | Secondary reformer waste heat boiler bundle | | E | 1996 |
| Triad Donaldsonville, LA, US | Capacity increase | 1,040 to 1,650 | E, P, C | 1996 |
| Yara, Trinidad | As-built P&ID's & debottleneck | | E,S | 1996 |
| JSC Cherepovets Cherepovets, Russia | Radiant reharp | | E, Pa, Ca | 1996 |
| Diamond Shamrock Sunray, TX, US | Radiant reharp, 2 plants | | E | 1996 |
| Ampro Donaldsonville, LA, US. | Hot leg convection section replacement | 1,630 | E, P, C | 1996 |
| Monsanto Chemical Luling, LA, US. | Reformer revamp | | E, Ca | 1995 |
| Terra Nitrogen Port Neal, Iowa, US | Repair after accident | | E, P, C | 1995 |
| P.T. Asean Aceh Fertilizer Lhokseumawe, Indonesia | Radiant reharp | | E | 1995 |
| Farmland Ind. Various, US. | Reformer revamps for 7 units | | E | 1993-5 |
| Ashland Chemical Plaquemine, LA, US | Radiant reharp | 1,400+ | E, Cm | 1994 |
| Canadian Fertilizer, Unit 1 Medicine Hat, AB, Canada | Reformer revamp | | E | 1994 |
| Sherritt, Inc Fort Saskatchewan, Canada | Convection section revamp | | E | 1994 |
| Koch Nitrogen, unit 1 Sterlington, LA, US | Reformer revamp | 1,630 | E, P, Ca | 1994 |
| Saudi Methanol, Unit 2 Al-Jubail, Saudi Arabia | Reformer revamp | 1,000+ | E, Ca | 1994 |
| Kribhco | Reformer revamp 2 units | | E | 1994 |

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| Razi Chemical Complex Bandar Khomeini, Iran | Reformer revamp 2 units | | E | 1994 |
| Ocelot Ammonia Company Kitimat, BC, Canada | Capacity increase, energy reduction, KRES system | | E, P, Ca | 1993 |
| DSM AGRO B.V. Geleen, The Netherlands | Advanced control system (KDAC) | | E, P | 1993 |
| P. T. Pupuk Kujang Cikampek, Indonesia | Optimization revamp | 1,230 | E, P, Ca | 1993 |
| P.T. Pupuk Iskandar Muda Lhokseumawe, Indonesia | Convection section modifications | 1,170 | E | 1993 |
| IFFCO Kalol, Gujarat, India | Reformer revamp | | E, Ca | 1993 |
| LaRoche Ind. Cherokee, AL, US. | Reformer revamp | 470 | E | 1993 |
| AMC. Catoosa, OK, USA | Reformer revamp | 1,360 | E, Ca | 1993 |
| Fertrin, Trinidad | Radiant reharp | 1,360 | E, P, Cm | 1993 |
| Kemira, The Netherlands | Heat exchanger | | | 1992 |
| Ocelot Ammonia Company Kitimat, BC, Canada | Capacity increase, energy reduction, KAAP | | E, P, C | 1992 |
| Koch Nitrogen, unit 2 Sterlington, LA, US | Reformer revamp | 1,400 | E, P, Ca | 1992 |
| AMC, Verdigris, OK, USA | Reformer revamp | 1,360 | E, P, Ca | 1992 |
| CFL, unit 2 Medicine Hat, AB, Canada | Reformer revamp | 1,450 | E, Ca | 1992 |
| Fertrin, Point Lisas, Trinidad | Plant revamp | 1,360 | E, P, Ca | 1991 |
| Farmland, Pollack, LA, USA | Advanced process control (KDAC) | | E, P | 1991 |
| Sherritt Gordon, Ltd Canada | Reformer waste heat boiler (101-C) | 1200 | E | 1994 |
| Canadian Fertilizers Ltd Medicine Hat, Alberta, Canada | Reformer convection section revamp | | E | 1991 |
| C.F. Industries Donaldsonville, LA, US. | Reformer revamp 2 units | 1,540 | E, Ca | 1991 |
| BP Chemicals, Lima, OH, US | Reformer waste heat boiler | 1600 | E | 1990 |
| Unocal Chemicals Kenai, Alaska, US | Converter replacement | | E, P [*] | 1990 |
| Cominco. Borger, TX, US | Upgraded synloop waste heat boiler | 1000 | E, Pa | 1990 |
| AmproDonaldsonvile, LA, US | Convection modifications | 1,360 | E, P, Ca | 1990 |
| Sherrit Gordon Fort Saskatchewan, Canada | Radiant reharp | 1,360 | E | 1990 |

LEGEND

- B - Basic Engineering Design
- E - Engineering PEQ
- C - Construction Services
- eB - Extended Basic Engineering

- P - Procurement
- FEED - Front End Engineering
- PEQ - E/P of KBR
- M - Management

*Revamped non - KBR technology base plant

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