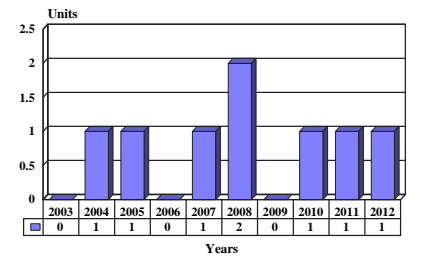


Kühnle, Kopp & Kausch Steam Turbines - Archived 8/2004

Outlook

- Company now producing only turbines and compressors
- Most KK&K steam turbines are in industrial use, with only a small number going into the electrical generation arena
- Power output expected to grow to 20 MW, but only on special order
- China likely to be its main customer for turbines and compressors

10 Year Unit Production Forecast
2003 - 2012



Orientation

Description. Impulse-type steam turbines suitable for either backpressure or condensing duty.

Sponsor. The development of the KK&K line of steam turbines was privately sponsored.

The current prime contractor/manufacturer is identified as the “prime” in the **Contractors** section below.

Power Class. The output power of the KK&K steam turbines is in the range of 45-5,000 kW.

Total Produced. At the start of 2004, about 20,000 turbines of all types had been fabricated, including steam turbines for use in combined-cycle installations.

Application. KK&K manufactures and supplies steam turbines to drive feedwater pumps, boiler-forced draught fans, mechanical drives for sugar cane processing, and electrical generators.

Price Range. KK&K has not made available the price range of its steam turbines since each is made to meet customer requirements.

Competition. Steam turbine machines from several manufacturers compete against the KK&K steam turbine product line for orders, most notably in Europe.

Contractors

Aktiengesellschaft Kühnle Kopp & Kausch (AG KK&K), Turbine Business Unit, [http:// www.agkkk.de](http://www.agkkk.de), Hessheimer Str. 2, Postfach 17 28, Frankenthal, 67227 Germany, Tel: 49 62 33 85 22 91, Fax: 49 62 33 85 26 60, Email: fur@agkkk.de, Prime

Technical Data

The information below applies to all KK&K turbines unless noted otherwise. The series designations have the following coding for identification purposes:

BF/AF Series (with axial-flow blade path)

- BF - Bearing block, overhung rotor arrangement (horizontal or vertical drive).
- AF - A-wheel, overhung rotor arrangement (horizontal drive).

AFA/CFA Series (direct-drive or with integrated, single-stage parallel shaft gear)

- AFA - A-wheel, overhung bearing design, axial-flow blade path.
- CFA - Curtis Stage, overhung bearing design, axial-flow blade path.

CFR Series

- CF - Curtis Stage, overhung bearing design, radial-flow blade path.

Materials. The following materials are generally used in KK&K steam turbines:

<u>Part/Location</u>	<u>Material</u>
Valve Casing, Turbine Casing	Heat-resistant cast steel
Exhaust Steam Casing	Cast iron or heat-resistant cast steel (depending on operating data)
Turbine Wheel Disc	Heat-resistant steel
Turbine Shaft	Annealed steel
Bearing Casing	Cast iron
Turbine Blades	Heat-resistant 12% chromium steel
Nozzle, Cone, Seat, Valve Spindle	Heat-resistant 13% chromium steel

Turbine Casing. The casing is vertically split, making the turbine wheel, nozzle system, and shaft gland easily accessible without removing the steam piping. The turbine casing is supported from the bearing casing via a centering ring which permits free radial movement when influenced by temperature.

All pressure casings are hydraulically tested. The rotating parts are statically and dynamically balanced. During the course of a works test run, the correct functioning of the control and safety devices is checked. KK&K can provide material certification to DIN 50 049 3.1 B for the principal steel castings and forgings.

Turbine Rotor/Wheel

BF/AF Series. Single-blade-row, axial-flow design.

AFA/CFA Series. Single-blade-row, one-piece turbine wheel for AFA. Double-blade-row, one-piece turbine wheel for CFA. Curtis wheel for CFA Series.

CFR 3/5 Series. One-piece, milled radial-flow wheel made of forged raw material.

Bearings/Bearings Design

AFA/CFA Series. Overhung bearing design, with only one shaft seal.

CFR 3/5 Series. Overhung bearing design, with only one shaft seal.

Nozzle System. The nozzle is bolted into the turbine casing.

Bearing/Gear Casing. The bearing/gear casing is horizontally split, thus allowing easy access to the bearings, oil pump, and drives.

Gearbox/Geared Systems

BF/AF Series. Integrally geared for high efficiencies.

AFA/CFA Series. The various gear modules and turbines can be combined with each other as required.

Control Systems. Control and trip valves are combined into a single valve. Hydraulic or hand-operated nozzle group valves can be installed. The steam turbines are protected against overspeed by a trip device.

Dimensions. The dimensions and weights of the KK&K line of steam turbines have not been made available.

Performance. The KK&K line of steam turbines have the following approximate performance parameters (all data are at maximum values):

AFA/CFA SERIES	<u>AFA 3,5</u>	<u>AFA 4</u>	<u>AFA 6</u>	<u>CFA 4</u>
Power	600 kW	2,200 kW	5,000 kW	1,600 kW
Speed	13,600 rpm	18,000 rpm	11,400 rpm	10,500 rpm
Live Steam Pressure	65 bar a.	131 bar a.	41 bar a.	41 bar a.
Live Steam Temperature	500°C	530°C	450°C	450°C
Exhaust Steam Pressure	1-17 bar a.	0.05-29 bar a.	0.05-11 bar a.	1-17 bar a.
BF/AF SERIES	<u>BF 3,5</u>	<u>BF 4</u>	<u>AF 3,5</u>	<u>AF 4</u>
Power	45 kW	225 kW	300 kW	750 kW
Speed	4,500 rpm	4,500 rpm	11,000 rpm	10,500 rpm
Live Steam Pressure	101 bar a.	46 bar a.	101 bar a.	101 bar a.
Live Steam Temperature	500°C	500°C	500°C	500°C
Exhaust Steam Pressure	1-8 bar a.	1-11 bar a.	1-17 bar a.	1-17 bar a.
CFR 3/5 SERIES	<u>CFR 3</u>	<u>CFR 5</u>		
Power	2,500 kW	5,000 kW		
Speed	23,000 rpm	14,000 rpm		
Live Steam Pressure	65 bar a.	65 bar a.		
Live Steam Temperature	480°C	480°C		
Exhaust Steam Pressure	1-17 bar a.	1-11 bar a.		

Variants/Upgrades

KK&K manufactures steam turbines to meet customer needs based on a selection among five turbine series as well as several gearbox variants. This allows for short delivery times not only for new systems but for spare

parts as well. Modifications to meet changed operating conditions can be made with minor expenditure.

For the performance parameters of the steam turbines, see Performance subsection above.

Program Review

General. The prime manufacturer is AG Kühnle, Kopp & Kausch (KK&K); Frankenthal, Germany.

The firm Aktiengesellschaft Kühnle, Kopp & Kausch is also referred to as AG Kühnle, Kopp & Kausch, AG KK&K, or merely as KK&K. The KK&K steam turbines are produced in Frankenthal, Germany.

Background. AG Kühnle, Kopp & Kausch (KK&K) builds steam turbines, fans, and compressors.

The company was founded in 1899. KK&K has been manufacturing turbomachinery since 1908; steam turbine production began in 1916. The turbocharger business was sold to 3K-Warner Turbocompressors in 1998. The company has been in the process of streamlining its business for the last few years, now focusing on its core business only.

The overall KK&K product range has five steam turbine series, five wheel sizes (300-600 mm), and seven gear/bearing blocks, allowing over 100 variants depending on the area of application.

BF/AF Series. Because of the overhung rotor design (turbine wheel mounted outboard of the bearing housing), it is possible to start the machine without preheating to full power. The start time is limited only by the mass moment of inertia of the rotating parts, and is typically about 10 seconds.

The turbines in this series are frequently used as stand-by machines (i.e., for safety backup against loss of electrical power).

CFR 3/5 Series. This series is considered the best choice for backpressure turbines up to 5 MW. It has the same construction features and advantages as the AFA/CFA series (see below), but with a one-piece, milled radial-flow wheel. It offers excellent efficiencies in both superheated and saturated steam regions via two-stage radial expansion.

AFA/CFA Series. This series features single- or double-blade-row, one-piece turbine, and automated nozzle group control; it offers high efficiencies for high-pressure ratios.

The AFA turbine is ideal as a saturated steam machine, and for applications where frequent starts and stops are required. The efficiency advantage of the AFA series (approximately 20 percent better than that available using conventional single-stage design) means that KK&K can offer a turbine with the efficiency of a multi-stage turbine for the price of a single-stage machine.

Machine Types

Tandem. Single-stage KK&K steam turbines are designed for coupling powers of up to 5 MW as determined by thermodynamic limits and by the gear construction. For plants where the higher electrical output is required, or for CHP schemes requiring a regulated extraction for heating purposes, the company has extended the typical turbine/driven machine arrangement by adding a second downstream turbine. With this tandem arrangement, the company can extend the range of application of its single-stage machines up to 10 MW.

Twin. The adaptability of the KK&K turbine program is apparent when the twin-type construction is combined with the tandem variant. With the use of the AFA and CFR lines, steam turbines can produce up to 10 MW electrical power and supply three main stems at the same time, with pressure regulation.

Gas Expansion Turbines. KK&K turbines of the AFA and CFR series can also be used as expansion turbines for almost any type of gas with only minor technical modification. They are used for natural gas expansion at gas pressure-regulated stations.

Technical modifications for this variant, as compared to the standard steam turbine, include a gas-lubricated mechanical shaft seal and special valve spindle seals which result in a completely gas-tight casing. In addition, low-temperature-resistant materials are used when required by the project.

Company Service. The company has representatives and service depots worldwide. The service teams cover everything involved in the setup of the plants, ranging from installation, erection, and commissioning to

overhaul, revision, and maintenance. A 24-hour service/ support hotline is available to customers.

Funding

It is unknown if KK&K used any European government or company resources in the development or modification of its line of steam turbines.

Recent Contracts

No known military contracts involving KK&K's steam turbine machines have been issued or received

Recent Activity

Several Orders. In June 2003, the KK&K turbine business unit received orders from various application fields: one machine for use in the production of sugar in Portugal, one for use in northern Germany as a drive for a pump, one for use in a biomass plant in Asia, and one from the Spanish department of agriculture for use in a plant that will produce energy from agricultural-generated gases, with the energy being fed into the regional grid.

Major Order from China. In January 2002, KK&K received an order to deliver a turbogenerator, including attachments, in China. The machine is to be delivered to the southern part of China by the end of 2003 for use as an energy source in the metals-production industry. The order is valued at approximately EUR900,000, considered to be a large order in KK&K's steam-turbine business sector.

Two Distribution Centers Established in China. Since the start of 2002, KK&K has enhanced its commitment to the Asian market by opening two distribution centers in China, one in Beijing and another in Shanghai. The Beijing office focuses mainly on the sale of products manufactured in Frankenthal, especially industrial compressors for sulfuric acid plants, coke gas applications, chemical plants and converter blowers. In addition, the Beijing office is responsible for the sale of steam turbines in China. The Shanghai office focuses mainly on the sale of machines of KK&K's Danish subsidiary HV-Turbo, and on the sale of compressors used for wastewater treatment.

Timetable

<u>Month</u>	<u>Year</u>	<u>Major Development</u>
	1899	Company founded
	1905	Compressor production begun
	1916	Steam turbine production begun
	1962	Turbocharger makers Holset, Schwitzer sign cooperation agreements
	1972	Takeover of Eberspächer's turbocharger program; development of K series turbochargers
	1982	MTU takes over majority of KK&K shares
	1985	Licensing rights to Wankel's mechanically driven compressor acquired
	1994	MTU/Munich sells its holdings in KK&K to Penske Transportation
	1995	Sale of the fan business unit
	1997	Penske sells its holdings in KK&K to Borg-Warner Automotive
	1998	Turbocharger unit sold to 3K-Warner Turbosystems; Schiele PGW Turbomaschinen bought
Jan	2001	KK&K acquires compressor manufacturer HV-Turbo A/S of Denmark KK&K opens two distribution centers in China (in Beijing and Shanghai)
Thru	2013	Continued production/aftermarket support of KK&K steam turbines projected

Worldwide Distribution

The vast majority of KK&K steam turbines have been installed in Europe, the Middle East, and the Far East/Asia/Australasia. Its market of the future is expected to be **China**, where steam turbines were first ordered in 2002.

Forecast Rationale

KK&K sold off its turbocharger business and now focuses on turbine and compressor production. It specializes in the lower end of the power spectrum, with the largest unit quoted as having a shaft output of 5 MW, which, when installed in a tandem configuration, yields up to 10 MW of power. Occasionally, larger turbines are manufactured, and our forecast chart below includes a few units in the 25-50 MW power band.

Considering that the company's strength is in the under-5-MW segment, KK&K could be one of the top contenders in the distributed power generation market that is growing geometrically around the world. Still, it will take a few years for manufacturers of this type of basic hardware to be fully comfortable with that trend.

The foundation of two distribution centers in China should result in more orders for KK&K's products in

that burgeoning market – for steam turbines as well as compressors. Since AG KK&K has decided to be represented on the Chinese market, orders should begin to grow in volume very shortly.

The focus of our coverage of steam turbines for combined-cycle power plants starts at 20 MW, and KK&K is projected to expand its product line to include machines of at least 20 MW in the very near future. We project that it will fabricate only a few of those machines during the decade extending through the year 2012, including machines for customers in China. Most of its steam turbine activity will focus on machines below 20 MW; we estimate 40-50 such turbines will be produced in the 10-year forecast period.

Ten-Year Outlook

ESTIMATED CALENDAR YEAR PRODUCTION

Engine/Machine	Application	thru 2002	High Confidence Level			Good Confidence Level			Speculative			Total 2003-2012	
			2003	2004	2005	2006	2007	2008	2009	2010	2011		2012
AG KUHNLE, KOPP & KAUSCH (AG KK&K) 20-49 MW STEAM TURBINES	COMBINED-CYCLE GENERATION	-	0	1	1	0	1	2	0	1	1	1	8