

Exhaust Gas Turbochargers

Programme 2010

Engineering the Future – since 1758.
MAN Diesel & Turbo



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Turbocharger Applications

Turbochargers type TCR, NR, TCA and NA

- Straightforward design
- Uncooled gas casings
- In-board plain bearing arrangement
- Lubrication by engine lube oil system
- High availability, reliability, durability
- High efficiency
- Easy maintenance and servicing
- Long lifetimes of components
- Long intervals between overhauls

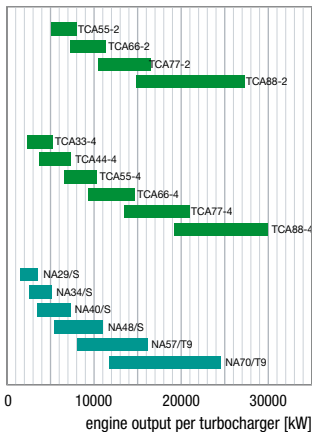
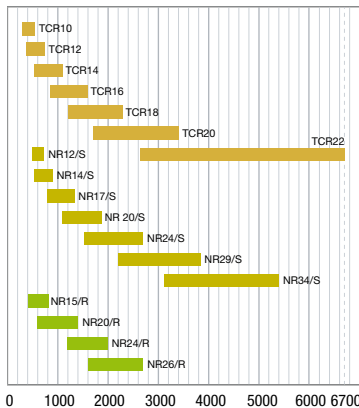
Applications for

- Propulsion engines
- Generating engines
- Traction engines
- Suitable for HFO, MDO and gas engines

Special equipment

- Tailormade solutions
- Power turbines
- Turbo Compound Systems
- Variable Turbine Area (VTA)

MAN Diesel & Turbo TCR, NR, TCA and NA turbocharger programme



The TCR Series

Benefits

- Ultimate performance
- Easy maintenance
- Increased life time of wear parts
- Simple installation
- Extended application range
- High power density, low weight and compact design
- Containment proven

Features

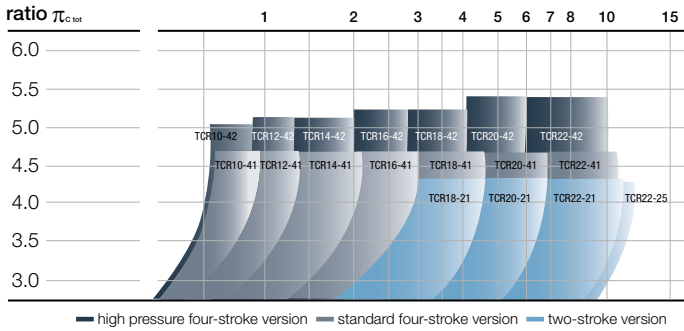
- Overall completely new design

Turbine

- New CFD optimised profiled rotor blades, nozzle ring, inlet and outlet casing for increased efficiency
- Constant and pulse pressure turbocharging
- Optional variable nozzle ring

Compressor pressure ratio $\pi_{C\text{ tot}}$

Compressor volume flow $V_{C\text{ tot}}$ [m³/s]



Bearings

- High performance plain bearings for minimised mechanical losses
- Optimised shaft diameter for increased efficiency
- Compact plain bearing concept for best rotor dynamic performance

Compressor

- New CFD optimised compressor wheel, diffuser ring and compressor volute for increased efficiency
- Extended pressure ratio and specific volume flow
- Internal flow recirculation for extended surge margin (option)
- New compressor wheel fixation for easy servicing

Easy maintenance

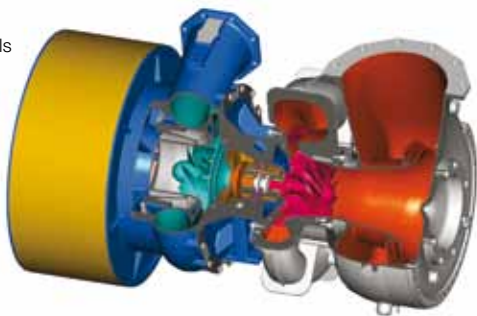
- Extended inspection intervals
- Easy access to compressor wheel
- Reduced number of parts

Smart design for convenient installation

- Uncooled casings
- Lubrication by engine lube oil system
- Integrated oil inlet and oil drain for pipeless design
- No sealing air required

Others

- Compliance with present and future engine standards and environmental legal restrains
- Containment proven
- Low moment of inertia for best dynamic behaviour



The TCR Series

Technical data

Turbine type	radial flow turbine
Max. permiss. temp.	700 °C
Pressure ratio	up to 5.4

■ Suitable for HFO, MDO, Gas

Turbocharger programme				
Type	Supercharged engine output [kW]		Max. permissible Speed [rpm]	Mass [kg]
	2-stroke le* = 8 kg/kWh	4-stroke le* = 6,5 kg/kWh		
TCR10	-	580	84,100	40
TCR12	-	800	71,300	100
TCR14	-	1,200	59,100	135
TCR16	-	1,750	49,100	205
TCR18	2,400	2,600	40,500	350
TCR20	3,500	3,800	33,600	600
TCR22	6,400	6,500	24,300	1,400

*Specific air consumption

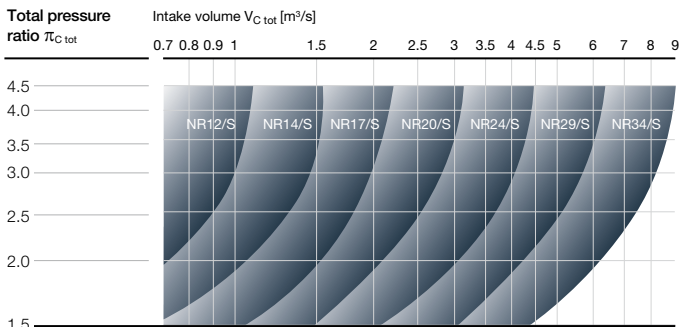
A close-up, black and white photograph of a large, multi-bladed metal rotor, likely a turbine or compressor. The blades are arranged in a circular pattern, with some showing a ribbed texture. The lighting creates strong highlights and shadows, emphasizing the metallic surfaces and the complex geometry of the blades. The background is a plain, light-colored surface.

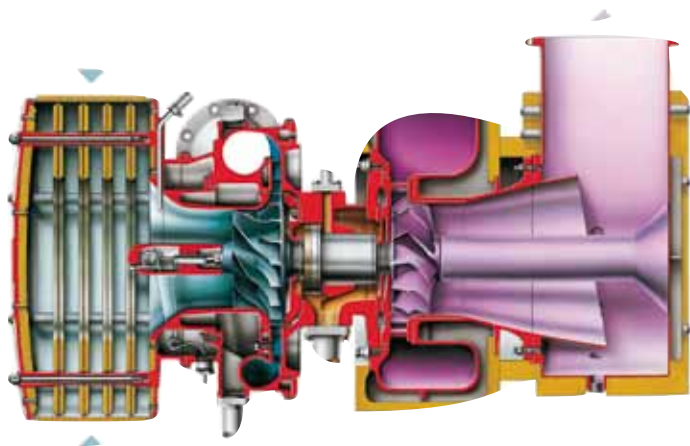
The NR/S Series

The NR/S Series

Features

- Compact in dimensions, simple in design, trouble free, long service life, easy to operate, HFO compatible up to IF-700
- In-board bearings lubricated by the engine's lube oil system:
 - compressor side: axial thrust bearing and radial floating bush;
 - turbine side: floating bearing bush;
 - lifetime of bearings more than 25,000 hours
- Totally water-free design
- Optimized flow components
- Extended range of application
- Pressure ratio of up to 4.5
- High efficiency level
- Ample margin to cope with future diesel technology requirements





The NR/S Series

Technical data

Turbine type	radial flow turbine
Max. permiss. temp.	650 °C (opt. 720 °C)
Pressure ratio	up to 4.5

■ Suitable for HFO, MDO, Gas

Turbocharger programme

Type	Supercharged engine output [kW] le* = 7 kg/kWh	Max. permissible speed [rpm]	Weight [kg]
NR12/S	670	75,000	155
NR14/S	950	64,000	190
NR17/S	1,350	52,600	260
NR20/S	1,870	44,700	350
NR24/S	2,690	37,300	505
NR29/S	3,820	31,300	780
NR34/S	5,400	26,300	1,450

* Specific air consumption

Overall dimensions

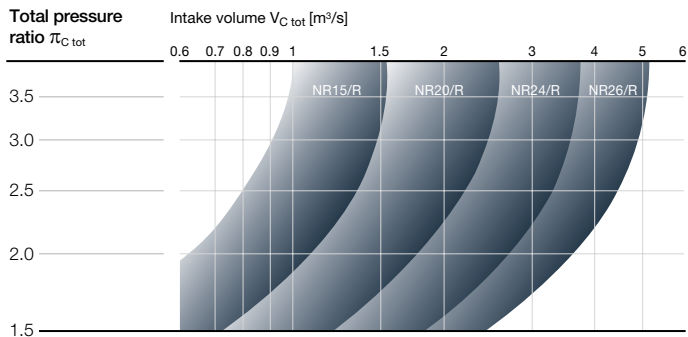
Type	Length [mm]	Width [mm]	Height [mm]
NR12/S	855	400	430
NR14/S	655	400	420
NR17/S	1,030	700	640
NR20/S	1,162	714	676
NR24/S	1,468	745	835
NR29/S	1,778	930	1,026
NR34/S	1,881	1,102	1,121

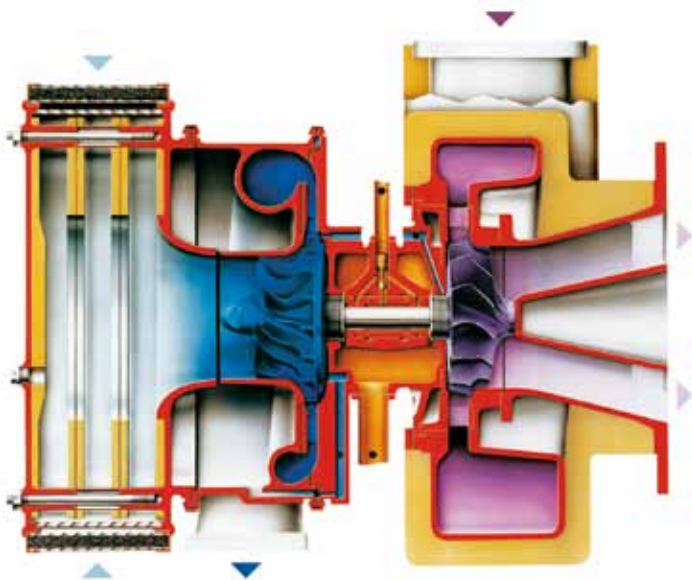


The NR/R Series

Features

- Compact in dimensions, simple in design, trouble free, long service life, easy to operate, HFO compatible up to IF-700
- Totally water-free design
- In-board floating bearing arrangement lubricated by the engine's lube oil system; lifetime of bearings more than 25,000 hours
- More than 30,000 units delivered worldwide for diesel engines of various applications and makes
- High efficiency over a wide operating range, resulting in low fuel consumption and lower gas temperatures; pressure ratio of up to 4.0





The NR/R Series

Technical data

Turbine type	radial flow turbine
Max. permiss. temp.	650 °C
Pressure ratio	up to 4.0

■ Suitable for HFO, MDO, Gas

Turbocharger programme

Type	Supercharged engine output [kW] le* = 8 kg/kWh	Max. permissible speed [rpm]	Weight [kg]
NR15/R	800	57,000	200
NR20/R	1,400	44,000	400
NR24/R	2,000	36,000	550
NR26/R	2,700	31,500	800

Overall dimensions

Type	Length [mm]	Width [mm]	Height [mm]
NR15/R	714 – 722	500 – 520	520 – 670
NR20/R	899 – 957	660 – 690	705 – 730
NR24/R	860 – 1,110	695 – 765	735 – 740
NR26/R	1,023 – 1,308	800 – 820	780 – 850

The TCA Series



The TCA Series

Features

Turbine

- Newly developed, wide-chord turbine blades without damping wire for increased efficiencies
- New turbine nozzle ring
- New optimised turbine outlet diffuser
- New optimised turbine inlet casing
- Variable Turbine Area – VTA (option)

Bearings

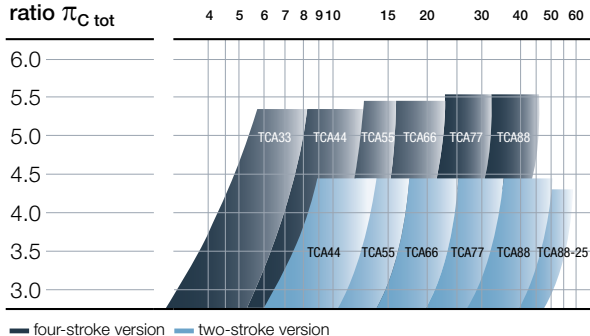
- Reduced shaft diameter for minimised mechanical losses
- High performance bearings for minimised mechanical losses
- Journal bearings for optimised damping behaviour

Compressor

- Newly developed compressor wheel with reduced noise emission, increased efficiency and optimisation to the engines' operating line
- New compressor diffuser vanes
- Newly developed compressor volute
- Internal Recirculation – IRC (option)

Compressor
pressure
ratio $\pi_{C \text{ tot}}$

Compressor volume flow $V_{C \text{ tot}}$ [m³/s]



Easy maintenance

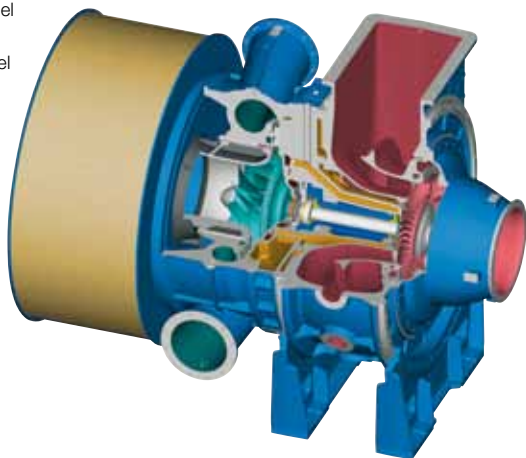
- Thrust bearing inspection without shaft removal
- Compressor wheel change with basic tooling and without dismantling of compressor casing
- Easy replacement of turbine blades

Extended life time of wear parts like

- Floating journal bearings
- Floating thrust bearing disk
- Cast nozzle rings
- Turbine blades
- Compressor wheel
- Optional titanium compressor wheel

Smart design for simple installation

- Uncooled casing
- Lubrication by engine lube oil system
- Integrated oil piping and oil venting system
- Integrated sealing air supply
- Reduced number of parts
- Integrated burst protection



The TCA Series

Technical data

Turbine type	axial flow turbine
Max. perm. temp.	2-stroke: 500 °C / 4-stroke: 650 °C
Pressure ratio	up to 5.5

■ Suitable for HFO, MDO, Gas

Turbocharger programme

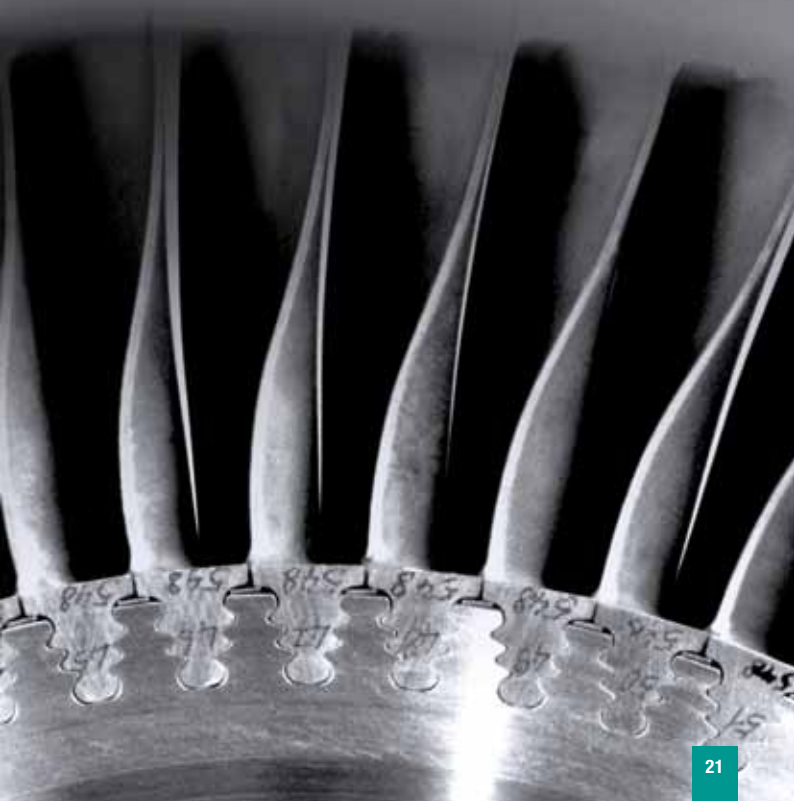
Type	Max. Supercharged engine output [kW]		Max. permissible Speed [rpm]	Mass [kg]
	2-stroke le* = 9 kg/kWh	4-stroke le* = 6,5 kg/kWh		
TCA33	-	5,400	27,800	1,140
TCA44	6,150	7,900	22,700	1,970
TCA55	8,000	10,400	20,100	3,290
TCA66	11,600	14,800	16,900	5,510
TCA77	16,600	20,900	14,200	9,250
TCA88	27,200	29,800	12,000	15,790

*Specific air consumption

Overall dimensions

Type	Length [mm]	Width [mm]	Height [mm]
TCA33	1,735	895	966
TCA44	2,084	1,075	1,160
TCA55	2,472	1,275	1,377
TCA66	2,937	1,515	1,636
TCA77	3,490	1,800	1,944
TCA88	4,144	2,138	2,309

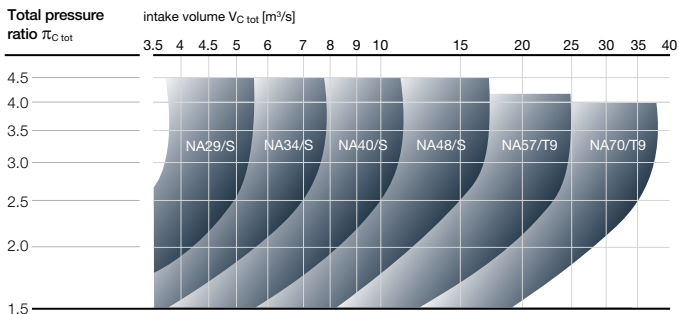
The NA/S/T9 Series



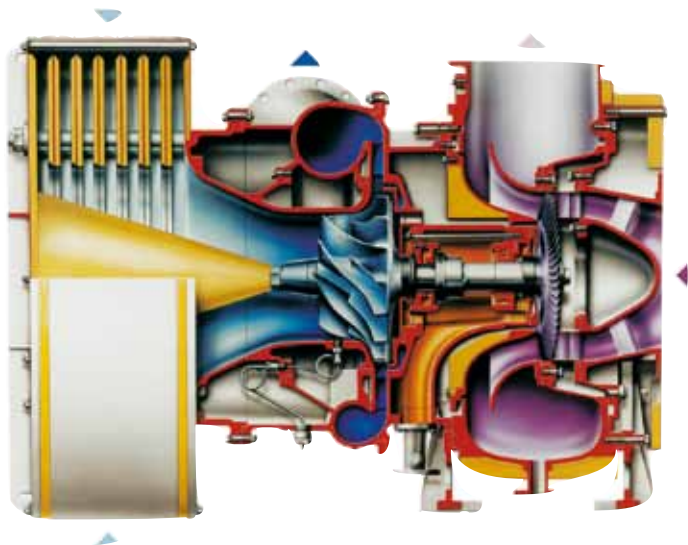
The NA/S/T9 Series

Features

- In-board arrangement of plain bearings, lubricated by the engine's lube oil supply system; lifetime of bearings more than 25,000 hours
- One-part compressor wheel milled out of high-strength aluminium alloy. The continuously backward bent blades lead to stable characteristics at a high efficiency level up to pressure ratios of 4.5 for NA/S (up to 4.2 for NA/T9)
- Enlarged turbine blades made of high-quality material with improved blading efficiency
- All casings of the NA/S turbochargers of "waterless" design
The bearing casings of NA57/T9 and NA70/T9 are water-cooled
- No corrosion of turbine casings with heavy fuel oil operation
- Excellent acceleration behaviour due to a low moment of inertia of the rotor
- Profiled nozzle ring
- Simple maintenance and long service life



The NA/S/T9 Series



The NA/S/T9 Series

Technical data

Turbine type	axial flow turbine
Max. permiss. temp.	650 °C
Pressure ratio	up to 4.5

■ Suitable for HFO, MDO, Gas

Turbocharger programme

Type	Supercharged engine output [kW] le* = 6,5 kg/kWh	Max. permissible speed [rpm]	Weight [kg]
NA29/S	3,600	31,300	1,050
NA34/S	5,100	26,300	1,350
NA40/S	7,300	22,400	2,200
NA48/S	11,000	18,600	3,700
NA57/T9**	16,100	15,000	5,100
NA70/T9***	24,500	12,000	9,800

Overall dimensions

Type	Length [mm]	Width [mm]	Height [mm]
NA29/S	1,025 – 1,310	890	920
NA34/S	1,268 – 1,990	950	1,355 – 1,440
NA40/S	1,435 – 2,286	1,130	1,540 – 1,630
NA48/S	1,807 – 2,709	1,322	1,759 – 1,879
NA57/T9**	1,994 – 2,879	1,537	2,033 – 2,133
NA70/T9***	2,502 – 3,547	1,920	2,550

* Specific air consumption

** Pressure ratio up to 4.2

*** Pressure ratio up to 4.0

The PT/PTG Power Turbine Series



The PT/PTG Power Turbine Series

Technical data

Turbine type	radial or axial
Max. permiss. temp.	550 °C
Output shaft speed:	1,800 rpm (1,500 rpm)

- Suitable for HFO, MDO, Gas

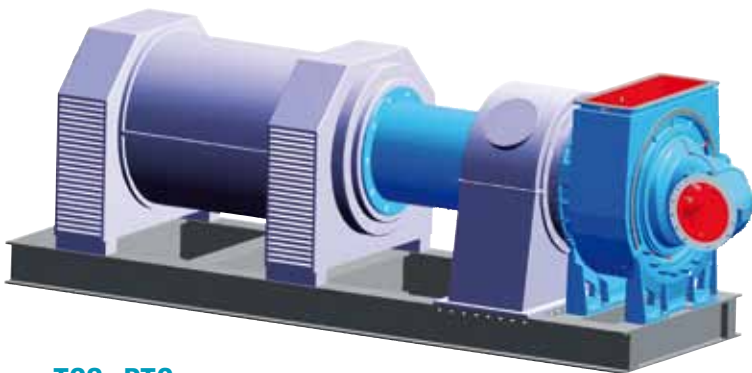
Main Features Power Turbines			
Radial Flow Turbine	Max. output [kW] $\Pi_T = 3.3$	Max. flow rate [kg/s] Temperature before turbine 450 °C	Max. speed [PT 1/rpm]
(TCS-) PTG18	850	6.2	34,000
(TCS-) PTG20	1,250	8.9	28,500
(TCS-) PTG22	2,200	15.2	21,500
Axial Flow Turbine			
(TCS-) PTG55	3,300	21.2	17,000
(TCS-) PTG66	4,700	30.0	14,500

The PT/PTG Power Turbine Series

PTG



TCS-PTG



The PT/PTG Power Turbine Series

Features

Exhaust gas turbine

- >> Newly developed high efficiency turbine
- >> New turbine nozzle ring with extended life time
- >> Bearing arrangement with long life time
- >> Axial: based on most modern TCA series
- >> Radial: based on most modern TCR series

Gearbox

- >> High efficiency high speed gearbox reducing turbine speed to generator speed

Couplings

- >> Gearbox to generator: high flexible coupling

Generator

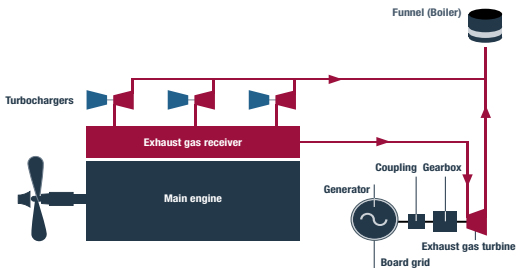
- >> Synchronous generator suited to marine applications
- >> Asynchronous generator suited to stationary applications

Exhaust Gas System

- >> Control valves for power turbine operating range
- >> Fast acting emergency valves for emergency shutdown
- >> Control and safety equipment

Optional: Variable Turbine Area (VTA) for exhaust gas turbine

- >> Increasing efficiency and flexibility of operation



The Variable Turbine Area (VTA)



The Variable Turbine Area (VTA)

Variable Turbine Area (VTA)

The VTA system consists of a nozzle ring equipped with adjustable vanes which optionally replace the fixed-vane nozzle rings in MAN Diesel & Turbo's standard TCA and TCR turbochargers.

By altering the pitch of the adjustable vanes, the pressure of the exhaust gases on the turbine is regulated and thus the volume of charge air can be precisely matched to the quantity of injected fuel at all points in an engine's load and speed range. The result is reduced specific fuel consumption, reduced emissions HC and CO₂ and improved engine response.

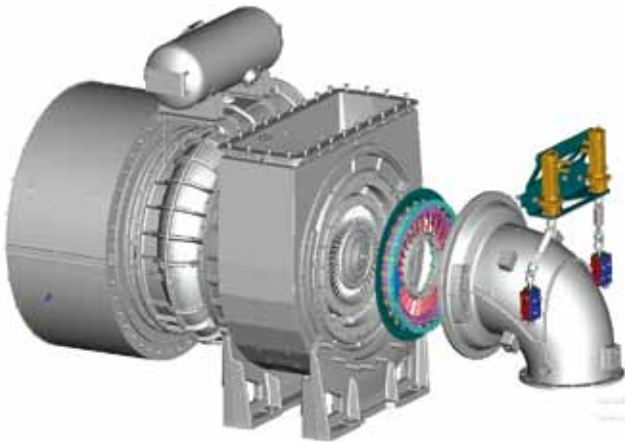
Benefits of VTA

- Up to 4g/kWh lower fuel consumption
- Lower soot and smoke emission
- Lower CO₂ emissions
- Lower particle emissions
- Suitable for TCA and TCR turbochargers
- Retrofit packages
- Short payback time
- VTA cuts fuel consumption and reduces emissions

The Variable Turbine Area (VTA)

Standard layout		Engine Load		
SFOC savings	g/kWH	75%	50%	25%
MC/MC-C/ ME/ME-C/ ME-B		2	2	2

Part load optimised		Engine Load	
SFOC savings	g/kWH	>75%	<75%
MC/MC-C/ ME/ME-C/ ME-B		0	4



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