REUSE, RECYCLE AND REDUCE OF WATER FROM STEAM WATER SYSTEM ANALYZER DRAIN IN THERMAL /GAS BASED POWER PLANT

Ch.V.A.S.Prakash[1], Dr.M.P.S.Murali Krishna[2], DK.V.S.G.Murali krishna[3]

[1]*DGM, Chemistry & SHEQ, Reliance Infrastructure's Samalkot Power Station, Samalkot, AP,* ***chaganti69@gmail.com***
[2]*Senior lecturer in chemistry, Department of technical education, Andhra polytechnic, Kakinada,* ***andal143@gmail.com***
[3]*professor in civil engineering, civil engineering Department, JNTU Kakinada, AP, India,* ***murali@nature.org***

Abstract:

Water reuse/recycle has gained much attention in recent years for environmental sustainability reasons, as well as the rising costs of fresh water and effluent treatment. Emphasizing the important role of process water conservation to improve the level of water use in power industry, the detailed analysis is made to the process water of gas based combined cycle power plant at various water consumption points. According to the features of each process and water consumption point separately, water-saving measures are proposed correspondingly aimed at maximizing the process water conservation and promoting the level of water saving in power industry. Study has been conducted on SWAS drains composite samples on several conditions. Reasonable samples were analyzed on continual basis. Recycling of SWAS drain is done. The water conservation that possible through this is evaluated.

Index Terms: *water reuse/recycle, conservation, power industry, swas drain*

-- *** --

1. INTRODUCTION

You never know the worth of water until the well is dry' (Scottish proverb).The thermal power industry stands first on the list of the five high-water consumption industries. Water availability represents a growing concern for meeting future power generation needs. In India, population growth rates, energy consumption patterns, and demand from competing water use sectors will increase pressure on power generators to reduce water use. Water availability and use also exhibit strong regional variations, complicating the nature of public policy and technological response. The paper analyzes power industry domestic situation and current water consumption and industry waste discharge conditions, discusses and analyzes specific measures of water saving and effluent reduction such as improvement of recovery ratio, comprehensive utilization of water.

2. LITERATURE REVIEW:

Joseph Alcamo(1984)1 presented the estimates of water requirements for future coal use, roughly 1–2 tons of water will be consumed for every ton-equivalent (tce) of coal-fuel delivered. However, these estimates assume a high degree of water conservation; with less emphasis on conservation, perhaps 50% more water will be required. Combined heat and power (CHP) generation is not a new concept, but it provides an elegant solution to some of our present fuel problems, offering, as it does, 80% or greater efficiency2. The cost effectiveness of each CHP-DHC system is highly sensitive to unit fuel prices, current discount rate, as well as the capital cost incurred. The operation of waste-water treatment plants is to a large extent energy-dependent. S.A. Tassou3 examined the energy requirements of these plants and explored ways of conserving energy through electrical and thermal load management and resource recovery and utilisation. Both energy and water provision in developing countries are running into an impasse, requiring drastic changes in planning philosophy. I.P.S. Paul presented the analysis of the concentrated efforts put in by Indian technologists for harnessing maximum energy from thermal power stations (TPS). The prime objectives have been to extract maximum energy from coal. All the controllable losses should be minimized in all operations and systems4. Paper of Nadeem A. Burney has examined possibilities of energy conservation in the generation of electricity and water in Kuwait. This has been done through analysing the underlying production structure by employing a translog flexible cost function and using series data5. In order to save water, the loading of supply system can be reduced if the cooling water can be recovered and reused. This study was initially focused on the current applications and reuse trends of cooling water in oil refineries, chemical industry, steel mills, food industry, electronics works, textile plants and power stations by Shu-Hai You6. Fu Lin, Jiang Yi studies the significant effect of the parameters, i.e. the supply and return water temperatures in the network, on the CHCP system energy consumption for cooling and for domestic hot water7.

Cogeneration of electricity and desalinised water — for water production — is an accepted principle in many countries. However, there is an opportunity to extend the concept to obtain greater efficiencies by reassessing the desalination paradigm. The new paradigm considers desalination as only part of the saline water processing chain. It looks at value-adding opportunities through further processing of salt by-products, particularly bitterns. It considers aspects such as multiple use of evaporation basins, electricity generation from solar ponds using bitterns as a main constituent, and opportunities for resource recovery from bitterns. Above all, it considers the integration of water, salt and power production, as a mutually supporting system. The overall concept of better integration of water, salt and power production is discussed with a focus on the utilisation of saline effluent from desalination plants8.

Reuse of industrial wastewater is an important strategy for reducing freshwater consumption and wastewater generation. X. Feng’s paper outlines a methodology for assessing the economic performance of industrial wastewater reuse systems that involve water upgrading. From an economic perspective, wastewater reuse reduces the costs of freshwater supply and wastewater disposal. Reusing significant quantities of waste water typically involves regeneration/treatment of the available wastewater to meet the higher water quality requirements of water-using activities. However, the cost of wastewater regeneration/treatment rises exponentially with increasing contaminant removal efficiency.

His paper demonstrates the importance of balancing these competing cost factor (freshwater and wastewater disposal costs vs. waste water regeneration/treatment cost), which are functions of the post-regeneration/post-treatment contaminant concentration. The proposed cost optimization procedure can be used to minimize the total cost of a wastewater reuse system with either wastewater regeneration reuse or wastewater treatment reuse9. Mousa S. Mohsen presents a study of the potential of industrial wastewater reuse in Jordan's Al Hussein thermal power station. A comprehensive review of the processes involved, industrial waste generation and water requirements was carried out, and areas of potential improvment were identified. They include a water treatment system, blow-down system, flue gas desulfurization and finding alternative process water sources such as using sewage treatment plant effluent as make-up water10.

Water reuse/recycle has gained much attention in recent years for environmental sustainability reasons, as well as the rising costs of fresh water and effluent treatment. Process integration techniques for the synthesis of water network have been widely accepted as a promising tool to reduce fresh water and wastewater flow rates via in-plant water reuse/recycle. In Dominic Chwan Yee Foo’s work 11, targeting for threshold problems in a water network is addressed using the recently developed numerical tool of water cascade analysis (WCA). Water pinch analysis (WPA) is a well-established tool for the design of a maximum water recovery (MWR) network. MWR, which is primarily concerned with water recovery and regeneration, only partly addresses water minimization problem. Strictly speaking, WPA can only lead to maximum water recovery targets as opposed to the minimum water targets as widely claimed by researchers over the years. The minimum water targets can be achieved when all water minimization options including elimination, reduction, reuse/recycling, outsourcing and regeneration have been holistically applied. Even though WPA has been well established for synthesis of MWR network, research towards holistic water minimization has lagged behind. S.R. Wan Alwi ‘s paper describes a new holistic framework for designing a cost-effective minimum water network (CEMWN) for industry and urban systems12.

Li Gao analyses the changes in the water efficiency of the production processes and technologies in five high-water-consuming sectors (HWCS; thermal power, iron and steel, paper production, textiles, and petrochemical). The study concludes that the main factors constraining water conservation include: backward technologies and processes; irrational industrial scale and composition and raw materials composition; as well as regional distribution. his study uses the bottom–up modeling approach; the end-of-pipe water use analysis method; and the cost-benefit analysis method to establish the industrial water conservation potential analysis (IWCPA) model13.

Malcolm Abbott reviewed the various measures that have been used to gauge the levels of productivity and efficiency in the water sector, with particular reference to input and output data requirements of these measures. summarised the key structural findings that have been determined from this research, particularly with respect to economies of scale and scope, public versus private ownership and the impact of regulation. then considered potential areas for potential future research, such as the effect of environmental management activities (including water conservation) and regulation on productivity and efficiency, the role of wastewater as a potential source of potable or ‘fit-for-purpose’water and the relationship between water supply and urban planning14.

A pilot study was conducted to determine whether membrane treatment on a side stream of recirculating cooling-tower water could reduce overall water usage and discharge by Susan J. Altman15. The treated permeate was returned to the cooling tower while the concentrate was discharged to the sanitary sewer. Flow rates, pressures and water chemistry were monitored. The pilot demonstrated potential substantial water savings. Maximum make-up water and discharge reduction were 16% and 49%, respectively.

Jiří Jaromír Klemeš presented a new formulation and a mathematical programming model for the direct recycle and reuse of mass exchange networks considering simultaneously process and environmental constraints. The model is based on mass and property integration. The properties constrained by the sinks include composition, density, viscosity, pH, and reflectivity, whereas the environmental constraints include the composition for hazardous materials, toxicity, chemical oxygen demand, color, and odor. The model eliminates most of the nonlinearities of the system, and the bilinear terms that remain are handled with a relaxation approach that yields a global optimal solution. The model minimizes the total annual cost that includes the cost of fresh sources and the annualized cost for property interceptors16.

To reduce chlorine usage and achieve a cleaner process, a new design for the cooling system of power plants is proposed. This can be accomplished by means of a cooling-stripping tower that operates in a closed circuit. With that purpose in mind, the design of such a cooling system configuration was undertaken. Results show that the warm stream leaving the condensers at 38 °C cools down to 27.1 °C after exiting the cooling-stripping tower. This decrease in the seawater coolant temperature before it is rejected to the sea therefore prevents thermal pollution. Furthermore, the small amount of seawater returned to the sea at 27.1 °C contains no chlorination by-products. In addition, a dramatic reduction in the seawater intake by the cooling system is obtained, and represents only 5.2% of that needed by conventional systems. This, in turn, implies a reduction in the chlorine dosage and the filter sizes required for the seawater input stream. It is recommended that all power plants consider implementing the proposed design in order to prevent seawater pollution and damage to coastal ecosystems17.

3. GEOGRAPHICAL LOCATION OF WORK

Samalkot Power Station (SPS) is located at Peddapuram in the state of Andhra Pradesh, the plant capacity is located at Peddapuram in the state of Andhra Pradesh, The Plant Capacity is 220 MW with an output capacity of 220 MW, The core machinery comprising of Gas Turbine Generator, Heat Recovery Steam Generator and Steam Turbine Generator along with their respective auxiliaries has been designed and supplied by Ansaldo. The construction of the project was initiated in October 1999 and the commercial operation commenced in December 2002. The Plant uses its primary fuel as natural gas, which is sourced from Gas Authority of India Limited (GAIL). It is also capable of using Naphtha as an alternative fuel. Raw water needed for the Plant is pumped to the in-plant open water reservoir from the Samalkot Irrigation canal. It is a combined cycle power plant. The power generated from the Gas Turbine and the Steam Turbine generators are stepped up to 220 KV and fed to a 220 KV outdoor substation. This power is transported by APTRANSCO through overhead transmission lines. In table: 1 given below is a year-on-year analysis of the plant's performance.

SPS Samalkot Plant Performance									
Parameters	**Units**	**FY 04-05**	**FY 05-06**	**FY 06-07**	**FY 07-08**	**FY 08-09**	**FY 09-10**	**FY 10-11**	**FY 11-12**
PLF	%	61	45.28	50.55	60.61	52.5	80.86	75.96	68.39
Availability	%	98.3	89.39	97.4	97.4	97.08	90.25	96.75	97.33

Table 1: plant performance for the past 8 years.

4. METHODS AND MATERIALS

There is a single assembly comprising of one Gas Turbine Generating (GTG) unit connected to its Heat Recovery steam Generator (HRSG) and one steam Turbine Generating connected to its Heat Recovery Steam Generator (HRSG) and one Steam Turbine Generating (STG) unit. The gas turbine generating unit is capable of delivering power in continuous operating and consists of combustion chamber, starting system equipment, filtered air intake system, fuel system, turbine and compressor wash system, AC generator & exciter, fire protection system, exhaust emission control arrangement, bypass stack, piping necessary instrumentation and control, and other associated auxiliary system equipments. The detail specifications are given in table 2 and 3 respectively.

Manufacturer	Siemens AG
Model	94.2
Fuel	Natural Gas, Naphtha, HSD

Output	140512 KW with Natural gas at 29° C ambient
Natural gas flow	9.284 KG/sec at 19.0 KG/cm2

Table: 2 plant specifications.

The HRSG is a dual pressure unit and generates high pressure and low pressure steam for the steam turbine generator from the GT exhaust gas.

STG Unit	
Manufacturer	Ansaldo
Type	Condensation, Extraction
No. of Cylinders	2 (HP & LP)
Steam exhaust	Horizontal

Table:3 STG unit details.

The various energy conservation measures that have been put into practice are:

- Installation of VFD in HPBFP, LPBFP, Raw Water Pumps
- De-staging of CEP
- Modification In DD Hydraulic Oil System
- Wind Turbo Ventilators
- Energy Efficient Lighting system
- Corrocoating of CW / ACW Pumps
- Installation of Energy Efficient Epoxy Coated Cooling Tower Cell Fan Blades.
- Modification of motor driven Cooling Tower Makeup system to Gravity System.
- Installation of High Efficiency Illumination system.

Maintaining water quality it is necessary to sample the water & continuously monitor the water quality supplied to the HRSG & steam to Steam Turbine Experimentation. SWAS(fig:1) is a diagnostic tool to monitor the healthiness of the Water & Steam parameters. For monitoring the water & steam condition, tapping is taken from the system & is supplied to analyzer & its drain is going to the atmosphere.

Fig:1 Steam Water Analysis System.

Feed water specifications	
Appearance	Clear
Ph @ 25°c	8.5- 9.5
Sp.Cond, µS/cm	<20
Silica as SiO2,ppb	<20
Ammonia, ppb	<1000
Dissolved Oxygen as O2,ppb	<7

Table: 4 water quality parameters at intake point

5. RESULTS AND DISCURSION

The Water Pollution rather water discharge points in the power plant are basically from the following sources. 1. Cooling Water System Blow Down, 2. Boiler Blow Down, (HRSG blow down), 3. Oil water separator waste water, 4. Demineralization plant Waste Water and 5. SWAS drain. Maintaining water quality it is necessary, to sample the water & continuously monitor the water quality supplied to the HRSG & steam to Steam Turbine. SWAS is a diagnostic tool to monitor the healthiness of the Water & Steam parameters. For monitoring the water & steam condition, tapping is taken from the system & is supplied to analyzer & its drain is going to the atmosphere. Study has been conducted on SWAS drains composite samples on several conditions. Reasonable samples were analyzed on continual basis. Table.1 is the data of parameters obtained for SWAS drain.

SWAS DRAIN WATER ANALYSIS (Excluding Drum Samples)			
Parameters	MAX	MIN	AVG
Ph	8.72	8.60	8.65
Sp.Cond, µS/cm	2.5	2.1	2..29
Silica as SiO2,ppb	2.86	2.60	2.72
Iron as Fe2+,ppb	3.2	1.8	3.4
Hydrazine, ppb	27.5	11.7	23.2
Ammonia, ppb	125	20	72
Phosphate, ppb	Nil	Nil	Nil

Table: 5 water quality analysis results of drain of SWAS.

On comparison of analytical data from table 4 and 5 it infers that SWAS drains quality is better than the Feed Water

Specifications. All the drain points are connected to one header and diverted to a collection tank/pit. Auto pickup and stop pump is provided to send this water to reserve feed tank from where is used for makeup of HRSG water circuit. This setup is diagrammatically represented in fig:2. Table 6 is presentation of SWAS water leaving into atmosphere in m^3 per day. Form the table one can estimate the water quantity leaving out into atmosphere at various points of plant.

SWAS WATER IN M³/DAY LEAVING INTO ATMOSPHERE		
S.No	Name of the Sample Point	Water in M³/d
1	Condensate extraction pp	1.676
2	LP-Feed Suction	0.864
3	LP-Economiser	0.753
4	LP-Steam	0.316
5	HP Feedsuction	0.895
6	HP-Economiser	1.139
7	HP-Steam	0.464
8	LP-Blowdown	1.021
9	HP-Blowdown	0.777
10	Gland Steam	0.705
	TOTAL	**8.610**
	Excluding Drum Water	**6.812**

Table6: SWAS Water in M³/DAY leaving into Atmosphere from various point.

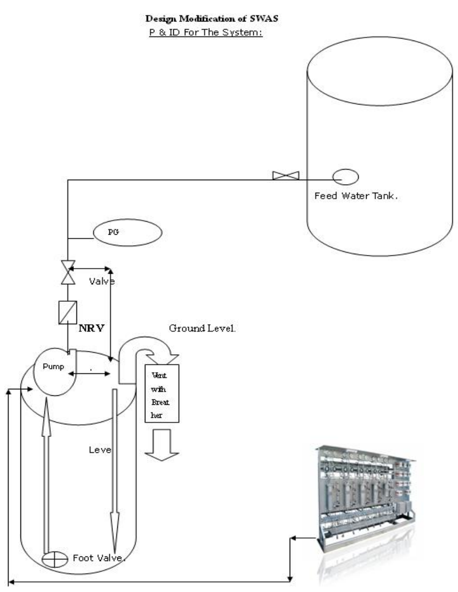

Fig:2 lay out diagram of recycling SWAS drain

Month	**meter reading**	**recovered water (M³)**	MOVING AVERAGE
Jun-2008	203.69	203.69	203.69
Jul-2008	398.08	194.39	199.0
Aug-2008	600.4	202.32	200.1
Sep-2008	790.52	190.12	197.6
Oct-2008	1004.56	214.04	200.9
Nov-2008	1185.99	181.43	197.7
Dec-2008	1379.38	193.39	197.1
Jan-2009	1568.5	189.12	196.1
Feb-2009	1727.14	158.64	191.9
Mar-2009	1930.29	203.15	193.0
Apr-2009	2145.79	215.5	195.1
May-2009	2346.46	200.67	195.5
Jun-2009	2556.81	210.35	196.7
Jul-2009	2760.3	203.49	197.2
Aug-2009	2949.57	189.27	196.6
Sep-2009	3125.34	175.77	195.3
Oct-2009	3151.09	25.75	185.4
Nov-2009	3359.69	208.6	186.6
Dec-2009	3585.71	226.02	188.7
Jan-2010	3800.54	214.83	190.0
Feb-2010	3958.02	157.48	188.5
Mar-2010	4114.33	156.31	187.0
Apr-2010	4300.12	185.79	187.0
May-2010	4450	149.88	185.4
Jun-2010	4667.26	217.26	186.7
Jul-2010	4852.35	185.09	186.6
Aug-2010	5032.24	179.89	186.4
Sep-2010	5195.2	162.96	185.5
Oct-2010	5397.28	202.08	186.1
Nov-2010	5564.54	167.26	185.5
Dec-2010	5713.86	149.32	184.3
Jan-2011	5859.04	145.18	183.1
Feb-2011	6004	144.96	181.9
Mar-2011	6186.7	182.7	182.0
Apr-2011	6359.64	172.94	181.7
May-2011	6546.78	187.14	181.9
Jun-2011	6717	170.22	181.5
Jul-2011	6936.48	219.48	182.5
Aug-2011	7133.12	196.64	182.9
Sep-2011	7329.23	196.11	183.2
Oct-2011	7515	185.77	183.3
Nov-2011	7675.5	160.5	182.8

Dec-2011	7874.35	198.85	183.1
Jan-2012	8088.39	214.04	183.8
Feb-2012	8271.68	183.29	183.8
Mar-2012	8465	193.32	184.0
Apr-2012	8660.28	195.28	184.3
May-2012	8865.3	205.02	184.7
Jun-2012	9082.42	217.12	185.4

Table 6: data pertaining to water recovered periodically and with moving average computed.

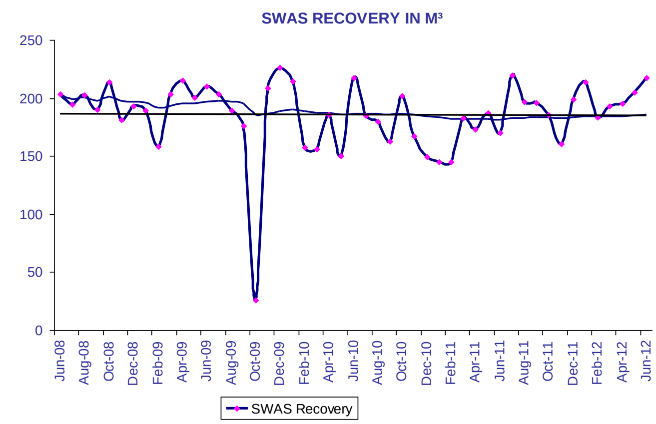

Fig: 3 plot between year and amount of water recovered from SWAS drain.

Recovery of water is not a uniform figure, as it is dependent on plant availability, non availability of the SWAS itself for any maintenance reasons. Maximum quantity as estimated in the above cannot be crossed. That is the reason the graph shows some range.

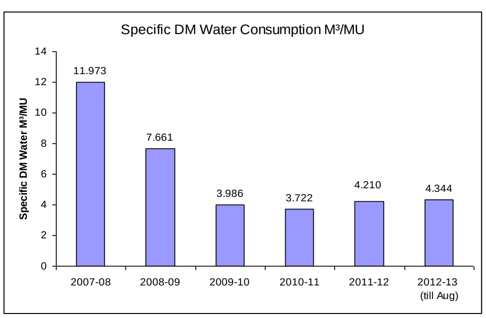

Fig:4 Bar graph showing the water consumption at DM unit in M^3/MU

The data collected periodically to get the extent of water recovered from SWAS. The highest amount of recovery has been reported in December 2009. The lowest recovery is in the month of October 2009 i.e. 25 m^3 is due major shot down of plant for annual maintain work. 184 m^3 will be the possible and optimized water recovery that can be achieved under prevailing conditions of plant. Fig :3 reveals that considerable volume of water has been recovered and recycled on overall average of 200 m^3 water could able to recovered. From the bar graph of Fig:4 it is evident there is a large change in specific DM water consumption before and after drain for recycling. After optimizing the performance of proposed system is attaining a constant recovery amount of water. The bar graph showing there is a change of water consumption from 11.973 per million units of power generation to 3.722 m^3 per million units of power generation.

CONCLUSION:

The water-saving of thermal/gas based power industry is of vital importance in the whole industrial rational use of water resources. Although the water conservation of power industry in India has made considerable achievements, there is still a large identified gap with foreign advanced level. By the detailed analysis of the water system of gas based power industry, the potential of its water-saving can be excavated further in the next step for the direction of its development. Through recycling and reuse of SAWS drain the water usage can be reduced. In the present studies it was found that there is direct savings on account of Water per annum: INR: 0.75 Lakhs/Annum. DM water makeup has come down to 0.2% (design 2.0%). Besides that there will a indirect savings from heating of makeup water.

ACKNOWLEDGEMENTS

The authors wish to thank Sri.C.Dwarkanath, Station Director for allowing me to do this work and also thank Vice President Sri KSN Murty and Plant Head Sri Soumitra Ray for their encouragement cooperation. The authors wish to convey thanks to Mr. K.Vijaya Bhaskar and Mr. D.Kanakam for providing valuable inputs in achieving the objective.

REFERENCES

[1]. Joseph Alcamo, Water and fire: Water needs of future coal development in the Soviet Union and the United States, *Resources and Energy*, Volume 6, Issue 2, June 1984, Pages 77-105.

[2]. R.F. Babus'Haq, S.D. Probert, M.J. Shilston, The total energy approach: Evolution of combined heat and power for district heating and/or cooling, *Applied Energy*, Volume 25, Issue 2, 1986, Pages 97-166

[3]. S.A. Tassou, Energy conservation and resource utilisation in waste-water treatment plants, *Applied Energy*, Volume 30, Issue 2, 1988, Pages 113-129.

[4]. I.P.S. Paul, S.C. Kaushik, S.P. Sabberwal, Energy conservation aspects in Indian thermal power stations by

technical innovations: Experience and prospective, *Heat Recovery Systems and CHP*, Volume 14, Issue 6, November 1994, Pages 639-649
[5]. Nadeem A. Burney, Faisal T. Al-Matrouk, Energy conservation in electricity generation: A case study of the electricity and water industry in Kuwait, *Energy Economics*, Volume 18, Issues 1–2, April 1996, Pages 69-79.
[6]. Shu-Hai You, Dyi-Hwa Tseng, Gia-Luen Guo, Jyh-Jian Yang, The potential .for the recovery and reuse of cooling water in Taiwan, Resources, *Conservation and Recycling*, Volume 26, Issue 1, April 1999, Pages 53-70
[7]. Fu Lin, Jiang Yi, Yuan Weixing, Qin Xuzhong, Influence of supply and return water temperatures on the energy consumption of a district cooling system, *Applied Thermal Engineering*, Volume 21, Issue 4, 1 March 2001, Pages 511-521.
[8]. Mushtaque Ahmed, Aro Arakel, David Hoey, Mark Coleman, Integrated power, water and salt generation: a discussion paper, *Desalination*, Volume 134, Issues 1–3, 20 April 2001, Pages 37-45.
[9]. X. Feng, K.H. Chu, Cost Optimization of Industrial Wastewater Reuse Systems, *Process Safety and Environmental Protection*, Volume 82, Issue 3, May 2004, Pages 249-255.
[10]. Mousa S. Mohsen, Treatment and reuse of industrial effluents: case study of a thermal power plant, *Desalination*, Volume 167, 15 August 2004, Pages 75-86.
[11]. Dominic Chwan Yee Foo, Flow rate targeting for threshold problems and plant-wide integration for water network synthesis, *Journal of Environmental Management*, Volume 88, Issue 2, July 2008, Pages 253-274.
[12]. S.R. Wan Alwi, Z.A. Manan, M.H. Samingin, N. Misran, A holistic framework for design of cost-effective minimum water utilization network, *Journal of Environmental Management*, Volume 88, Issue 2, July 2008, Pages 219-252.
[13]. Li Gao, Wen Zongguo, Du Bin, Zhang Chao, Chen Jining, An analysis of industrial water conservation potential and selection of key technologies based on the IWCPA model, Resources, *Conservation and Recycling*, Volume 52, Issue 10, August 2008, Pages 1141-1152.
[14]. Malcolm Abbott, Bruce Cohen, Productivity and efficiency in the water industry, *Utilities Policy*, Volume 17, Issues 3–4, September–December 2009, Pages 233-244.
[15]. Susan J. Altman, Richard P. Jensen, Malynda A. Cappelle, Andres L. Sanchez, Randy L. Everett, Howard L. Anderson Jr., Lucas K. McGrath, Membrane treatment of side-stream cooling tower water for reduction of water usage, *Desalination*, Volume 285, 31 January 2012, Pages 177-183.
[16]. Jiří Jaromír Klemeš, Industrial water recycle/reuse, *Current Opinion in Chemical Engineering*, Available online 18 April 2012.
[17]. María J. Fernández Torres, Francisco Ruiz Beviá, Chlorine use reduction in nuclear or conventional power plants: a combined cooling-and-stripping tower for coastal power plants, *Journal of Cleaner Production*, Volume 26, May 2012, Pages 1-8.

BIOGRAPHIES

Dr.M.P.S.Murali Krishna working as senior lecturer in chemistry in Andhra polytechnic. So far published 10 research papers in various national and international journals and presented many papers in conferences. Chemometeics, lignin chemistry, computational methods and environmental chemistry of persisted organic pollutants are subjects of his research interest.

Prof KVSG Murali Krishna has been working in JNTU Kakinada in civil department. He has presented more than 30 papers in various journals and conferences. He is author of many books on environmental engineering and personality development. He is a good orator and motivator and practicing environmentalist.

Prakash.V.A.S.Chaganti working as Dy. General Manager (Chemistry-SHEQ) in Reliance Infrastructure's Samalkot Power Station., So far published in 4 four papers in national magazines. He has 20+years of experience in the Power Plants in Chemistry & SHEQ departments and instrumental in implementing various Water conservation methods.