
AIR
PRODUCTS

ASU / IGCC Integration Strategies

Dave McCarthy

Air Products and Chemicals, Inc.

Gasification Technologies 2009
Colorado Springs, CO
5 October 2009

Agenda

- **Proven Large-Scale Oxygen Supply: Cryogenic Air Separation Units**
  - **Industry experience with very large ASU**
  - **Overview of the process**
- **ASU Challenges specific to IGCC**
- **ASU Reliability and Operability**
- **Conclusions**

AIR PRODUCTS

How Will Air Products Help Make IGCC Projects A Success ...

- **A long history of Innovation**
- **Geographic diversity for engineering and procurement, worldwide experience in building ASU's**
- **Large scale ASU experience worldwide**
- **Application experience – we've supplied oxygen/air separation equipment for all major gasification technologies and specifically the IGCC application – we've "sweat" the details**
- **Reliability - first company to supply high-reliability tonnage oxygen for gasification projects without oxygen backup**
- **Very high pressure oxygen experience - Lead the industry in operating experience supplying tonnage oxygen up to 1,500 psig**
- **A focused group of individuals to support gasification and its customers through Definition, Optimization, FEED, Execution, Startup and Operations**
- **We will treat the plants like one of our own**

AIR PRODUCTS

ASU Flow Diagram/Train Configuration

Main Air Compression

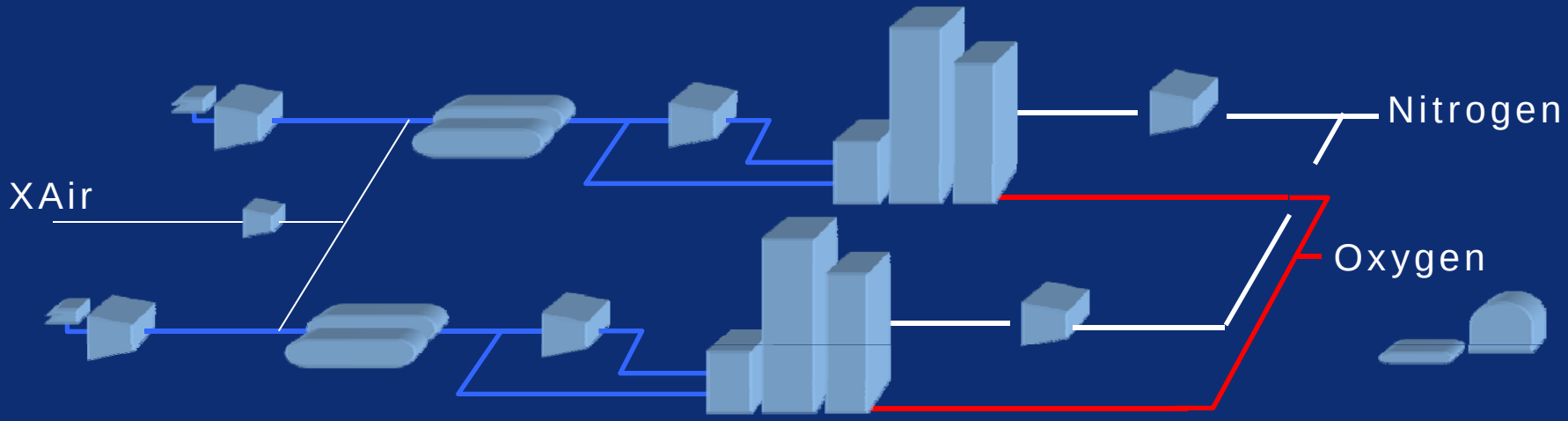
Air Pretreatment

Boost Comp'r

Cryogenic Separation

Storage

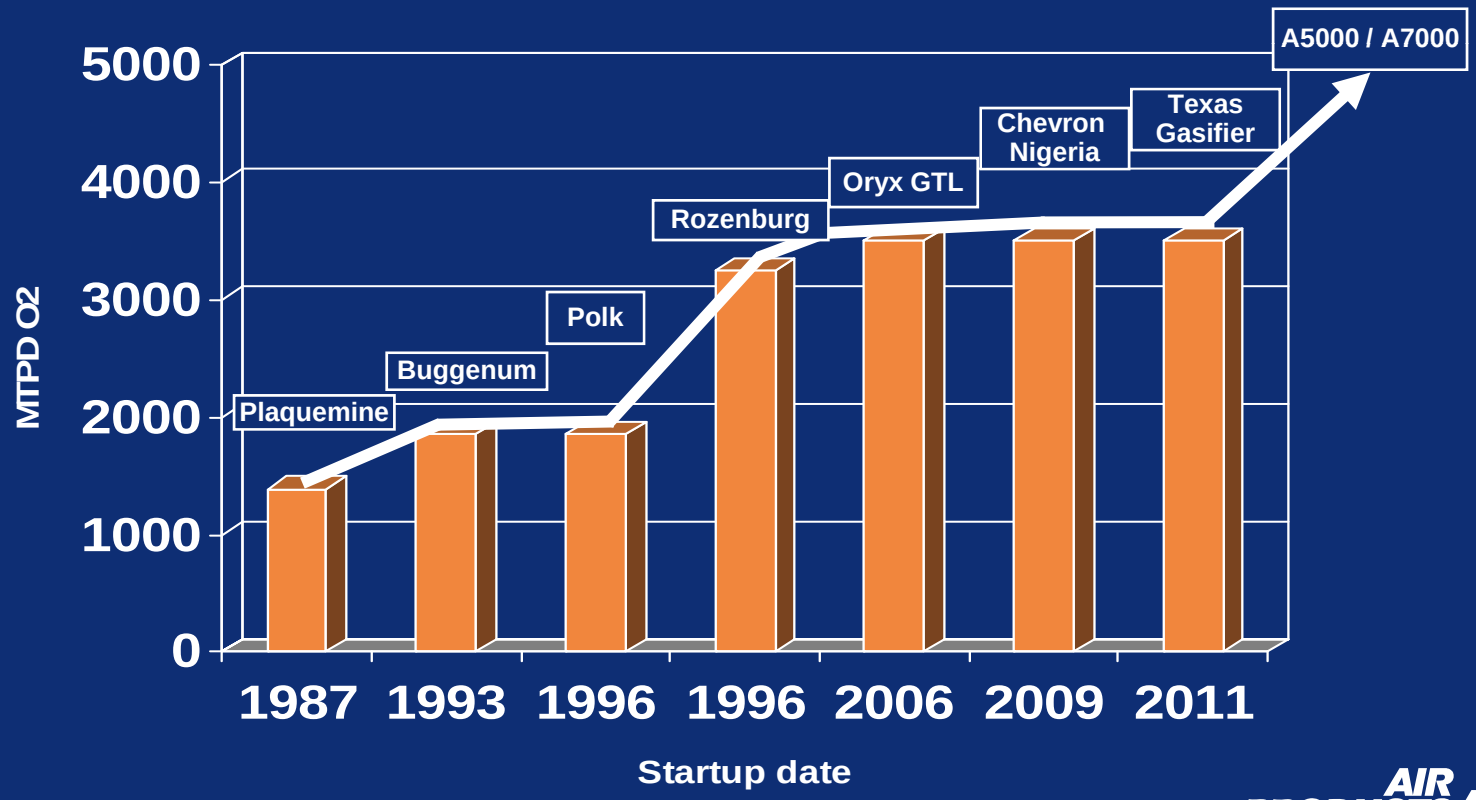
N2 Compression



AIR PRODUCTS

Experience - Large ASU Projects and Train Scale-up

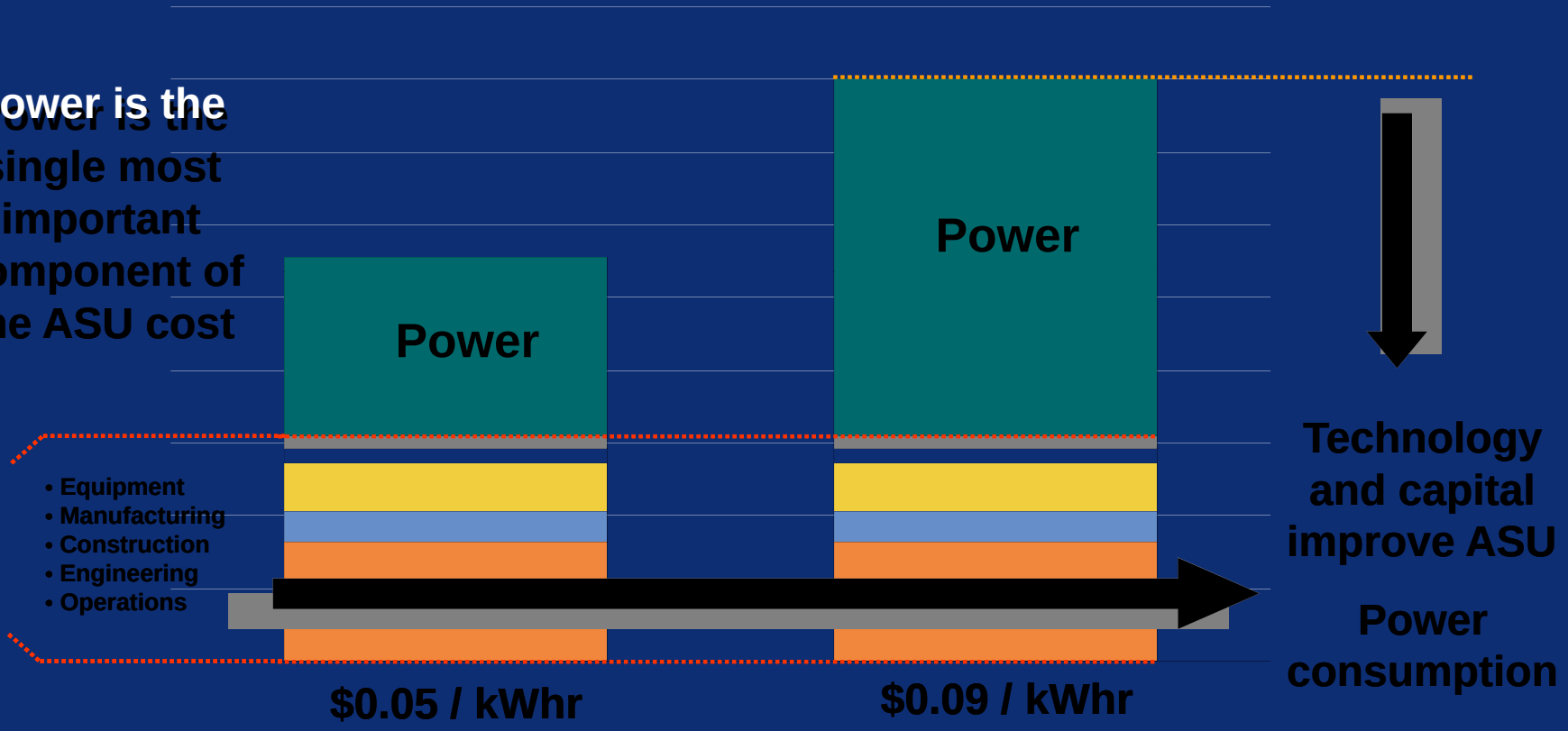
- Market drives ASU scale-up
- Proven 70% scale-up
- Quoting 5,000+ MTPD today



Large air separation units (ASUs)

Power Costs and Design

Power is the single most important component of the ASU cost



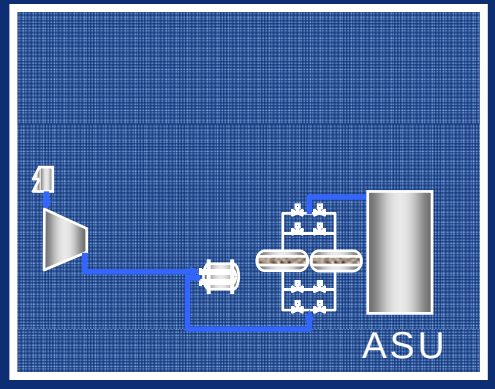
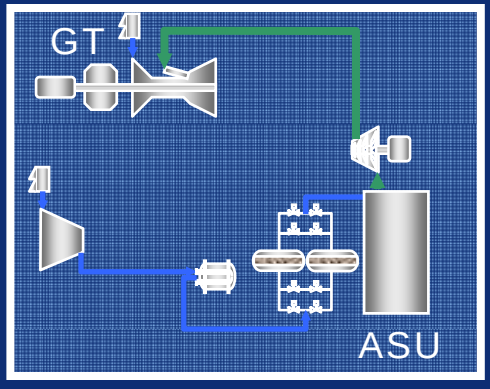
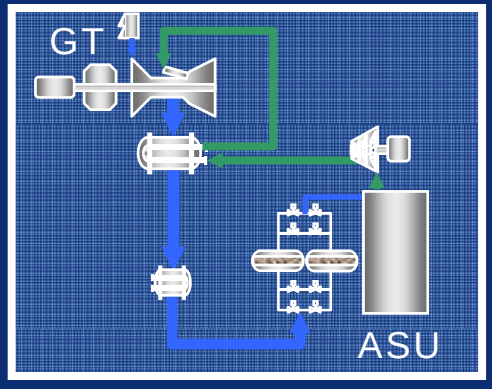
AIR PRODUCTS

Process Cycle Selection Criteria

- Oxygen profile
  - Purity
  - Pressure
  - Demand pattern
- Argon co-production required?
- Power evaluation criteria
- Capex sensitivity
- Process integration philosophy
- Site constraints, e.g. logistics, utility availability & quality, water consumption
- Operating constraints, e.g. availability, reliability, time to on stream, ramp rate.

IGCC Integration Experience

- **Proven air and nitrogen integration experience**

No Integration Various Projects 1,350 to 3,500 sTPD	N2 Integration Tampa Electric (1996) 2,020 sTPD	Air + N2 Integration Demkolec (1994) 1,960 sTPD
		
		

AIR PRODUCTS

LASU Design challenges to IGCC power plants

Design based on customer's specific requirements:

- **Parasitic load**
  - **Power vs. Capital costs**
  - **Purity requirements**
  - **Co-products**
  - **Compression integration**
  - **Utility Integration**
- **Operability**
  - **Fit with customer's use patterns**
    - **Turndown / ramping up**
  - **Advanced control capabilities**

AIR PRODUCTS

LASU Execution challenges to IGCC power plants

- **Manufacturing**
  - **Transport of ASU(s) to site**
  - **Reducing construction / erection costs and risks**
- **Start-up**
  - **Shared Utilities**
  - **Back-up systems**
  - **Compression integration**
- **Reliability**

Process Integration Goals and Methods

- **Reduce cost/improve efficiency without compromising operability**
  - **“Easy” integrations**
    - **Use of by-product energy (Steam)**
    - **Combined utility systems (Cooling Water)**
    - **Air/nitrogen integration with gas turbines**
  - **“Harder” integrations**
    - **Internal streams between process units**
    - **Start-up requires other units to be in operation**

Reliability

- **Air Products operates the majority of plants that it designs and builds**
- **Thousands of man-years of ASU operating experience includes customers that require 100% availability of products**
  - **Average plant availability is greater than 99%**
    - **Average duration of plant trip is ~16 hr**
    - **Spare parts handling strategies in place**
    - **Maintenance shutdown once/3+ yrs**
      - **Coincide with normal power plant maintenance**
  - **Instantaneous back-up systems in place today in safety-sensitive and electronic applications**

Operability: Plant Ramping & Advanced Controls

- **Benefits of Advanced Control capabilities**
  - **Lower power consumption**
  - **Higher product recoveries**
  - **Faster disturbance response and mitigation**
  - **Faster response to changing product demands**
  - **Higher multi-plant efficiency**
- **ASU ramping capabilities**
  - **1%/min typical**
  - **2%/min achievable with advanced control**
  - **3%/min possible when “designed in”**
  - **Higher rates possible by using liquid oxygen backup**

Summary

- There is a major new industry requirement for ASUs for fossil-fuel fired power generation
- ASUs have changed a great deal in the past 15 years
  - New cycles
  - Structured packing for distillation
  - More power efficient
- Single train sizes over 5000 ton/day
- Integration opportunities
- Manufacture/erection approach is project specific

AIR PRODUCTS

It is about more than just O_2...

- **APPLICATION EXPERIENCE: Supplied large oxygen/air separation equipment to all type of applications and industries:**
  - **Power, Gasification, Refining / Petrochemicals**
- **INTEGRATION EXPERIENCE: Air separation plants in all integration modes—**
  - **Oxygen supply control system**
    - **Load following, start-up shutdown, peak-shaving**
  - **Compression heat recovery**
  - **Standalone, nitrogen integrated, and air/nitrogen integrated (IGCC)**
- **MEGA-TRAIN EXPERIENCE: Operating very large single train air separation plants since 1997 in Rozenburg, The Netherlands (3250 MTPD); also installed a 2x3500 MTPD unit in Qatar**
- **RELIABILITY: First company to supply high-reliability tonnage oxygen for power projects without oxygen backup**
- **OTHER GAS PRODUCTS: Broad industrial gas industry experience creates synergies with H2, CO, and CO_2 markets**

AIR PRODUCTS

Thank you

tell me more

www.airproducts.com