

Quebec City, Canada

VFD Pump Applications

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American Society of Irrigation Consultants | ASIC 2018 NATIONAL CONFERENCE



1) VFD defined.

- 2) The application of VFDs to single phase input power. Infrastructure across the US struggles to keep up with population growth.
- 3) VFD per pump Needed? Specific applications.
- 4) Pump curves and VFDs Pump selection tips.
- 5) VFDs applied to submersible pumps.
- 6) Using the VFD's on-board logic as a pump controller.
- 7) Application of VFDs to existing (older) motors.

Topic #1 - What's a VFD?

- Variable Frequency Drive
- Variable Speed Drive
- Adjustable Frequency Drive
- Adjustable Speed Drive
- Drive
- Inverter



A device used to vary the speed of pump(s) to regulate downstream pressure. Energy savings result. May be applied as a 1φ to 3φ phase converter when only 1φ phase power is available.

- The VFD is installed between the primary power and the motor.
- In water pumping applications to regulate pressure by varying the speed of an AC motor.
- Can operate a pump directly, with its on board (limited) logic.
- More commonly, one component of a more complex control platform.





VFDs Packaged with Engineered Controls





Topic #2 - VFD applications with 1φ input power

• VFD sizing

- Primary power component sizing
- Line reactor(s)
- Panel cooling
- Multiple pumps

- VFDs are capable of driving 3φ motors using only 1φ input. Big benefit when the cost of upgrading the electrical service from 1φ to 3φ is prohibitive.
- Note The 1φ VFD input current will be higher than if 3φ by a factor of √3 (1.732).
- VFD size must be increased to handle the additional input current (Amps).







Example:

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10 HP motor = 24 Amps at 230 V, 3\phi
24 Amps x 1.732 = 41.57 Amps at 230 V, 1φ
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Check with VFD manufacturer for their application guide for sizing drives for 1 ϕ input. General rule is to double (2x) the 3 ϕ drive current rating.

The VFD manufacturer would likely require a minimum VFD current rating of 48 Amps, connecting to a 10 HP motor at 230 V, 1ϕ .



Other considerations...

- Panel size Drive has larger footprint, and one drive per pump is required.
- Line reactor on VFD primary is required by some drive manufacturers.
- Control cabinet cooling (when applicable).





- 1φ control panel
- Pumps: 2 x 60, 1 x 15 HP
- Line reactors.
- Larger panel @ 90" wide.
 If this were a 3φ panel, it would be 48" wide.





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- 70%+ of heat generated by a VFD is through the power output section (motor).
- Only a small amount of heat is generated at the VFD input (rectification).
- Panel cooling need not increase for one or two pump (VFD) system.

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Topic #3 - 3φ applications using a VFD per pump

Why incorporate a VFD per pump?

- Varying inlet pressure primarily booster applications. Lift apps OK.
 - We design around worst case inlet pressure. The majority of the time, the inlet pressure may be much higher.
 - If the need for the booster system is primarily to compensate for friction loss, Δ Pressure correlates to (Δ Flow)². If the flow is reduced to 1/2 of the max design flow, the friction loss is reduced to 1/4.
- Example A system designed for a 30 PSI total friction loss pressure drop at the pump inlet will only experience a 7-1/2 PSI drop at half
 flow. 22-1/2 PSI surplus.

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3¢ applications using a VFD per pump

- A variation of inlet pressure > 10 PSI can be problematic.
- Individually regulated pumps greatly opens the pressure variation "window."

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3¢ applications using a VFD per pump



Why incorporate a VFD per pump?

- Varying discharge pressure
 - New pump station installed this year. New irrigation system installed in the future that requires 15 fewer PSI. Can a constant speed pump accommodate both duty points? We are much more likely to satisfy both duty points if we can individually control pumps.
 - Variable discharge pressure to field based on demand or input from irrigation system.
- Control panel simplicity
 - Fewer components, wire, labor

Panels - VFD per pump versus a shared VFD



Panels - VFD per pump versus a shared VFD





Panels - VFD per pump



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3¢ applications using a VFD per pump



Potential concerns

- HEAT! For every VFD that is added to the control panel, extra heat must be removed. Higher capacity cooling required.
- Vulnerability to electrical power problems (surges, strikes). If every pump has a dedicated VFD, then a single power surge could potentially damage all the drives, knocking all pumps off line.
 - Incorporate higher capacity surge/ lightning protection (not a guarantee).
 - Add bypass contactors to allow pumps to operate x-line.

Panels - VFD per pump with bypass contactors



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Topic #4 – Pump curves & Steep, Flat, Declining

- A steep curve reduces energy draw in VFD applications as the flow is reduced.
- A flat curve is desirable for constant speed applications.
- A declining curve should be avoided. Can result in VFD "hunting" and pressure/ flow oscillation.

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Topic #5 - VFDs applied to submersible pumps

- Submersible motors draw more current (Amps) than horizontal or vertical motors of equal HP.
- Panels for submersible systems often require higher (Amp) capacity equipment. Contactors, wires, disconnect.
 - Example: 30 HP motor Amp draw at 480 V, 3φ
 - BALDOR Horizontal = 34 Amps
 - NIDEC Vertical Hollow Shaft (VHS) = 35 Amps

Sub Amps=

VHS x 113%

Hor x 116%

- FRANKLIN 6" Submersible = 39.5 Amps
- With knowledge of the application, panel manufacturers know the rules in sizing equipment properly.

Topic #6 - Using a VFDs on-board logic for control

- Connect a pressure transducer to a VFD and automate a single pump.
- Daisy chain multiple VFDs together and create a pump control platform.
- Benefits:
 - Reduced cost and material count.
 - Works best on single pump.
- Drawbacks (multi-pump):
 - Limited control functions and versatility.
 - Can be more difficult to commission and troubleshoot.
 - Limited local and remote monitoring capability.
 - Drive manufacture at their discretion can discontinue or change logic.



Topic #7 – VFDs applied to existing motors



- Older motors (x-line especially) applied to new VFD controls may experience winding failures, often within 1 year of application.
 - VFDs apply higher Voltage to the motor windings. Exposes breakdown in winding insulation. Windings arc φ to φ, or φ to ground.
 - Check to see if the existing motor is Inverter Rated.
 - Even if the motor is Inverter Rated, it may have degraded winding insulation through normal wear, elevated temperatures, unchecked condensation, coastal/ dusty locations.
- Insist on a winding megger reading to ensure winding integrity.
- Transport the motor(s) to a trusted motor shop for a full inspection if megger reading is inconclusive.

VFDs applied to existing motors



VFDs applied to existing motors

- Example of a newly rewound motor stator.
- Extra dip and bake cycles of varnish
- Extra phase paper in the stator slots
- Extra winding wraps at the end turns.



VFD Pump Applications





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Middle East Landscape Architecture

Rob Wassem, HydroPoint Data Systems

Goals of our Discussion

- Define "The Middle East"
- Who is spending and who's doing the design
- Types of projects
- How do I relate
- Sustainability
- Projects
- Best Practices



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What do you picture when you think of the Middle East – The Food & Its Culture



Regardless of any pre-conceived assumptions, the Middle East cannot be summed up as one culture as it's many cultures, traditions, peoples and faiths. The Middle East's desire to improve their environment with modern landscape architecture is almost obsessive which provides us a unique opportunity to influence in a positive way.

"Landscape architecture and creating attractive open spaces in urban areas is becoming more of a factor in design across the Middle East" Source HOK



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Define The Middle East



Geographers and historians do not always agree on which countries should be included in the *Middle East*. The US State Department includes the following countries: **Turkey**, Syria, Lebanon, **Israel**, Jordan, Iraq, Iran, Afghanistan, **Saudi Arabia**, Yemen, **Oman**, the **United Arab Emirates**, Qatar, Bahrain, Kuwait, Egypt, Libya, Sudan and others totaling 22 countries.

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The **United Arab Emirates** is a federation of hereditary absolute monarchies. It is governed by a Federal Supreme Council made up of the seven emirs of **Abu Dhabi**, Ajman, Fujairah, Sharjah, **Dubai**, Ras al-Khaimah and Umm al-Qaiwain.

*Areas in bold are considered growth opportunities according to International Federation of Landscape Architects (IFLA)

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The Middle East Map



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The Middle East GDP

Rank		Country	GDP Per Capita	GDP Total (USB\$)	GDP (M\$)
1	¢	Israel	\$35,200	\$281	296,100
2	*	Iran	\$18,100	\$876	416,490
3		Kuwait	\$71,900	\$150	172,608
4		United Arab Emirates	\$67,900	\$200	399,451
5		Oman	\$46,700	\$69	77,677
6		Bahrain	\$50,700	\$23	33,862
7	9070A	Saudi Arabia	\$55,200	\$581	746,248
8	Ċ•	Turkey	\$24,900	\$1,190	798,332
9	٠	Lebanon	\$18,500	46	50,028
10		Qatar	\$127,700	\$101	210,109
11	-	Egypt	\$12,600	\$470	286,435
12		Jordan	\$12,300	\$33	35,878
13	• •	Syria	\$2,900	\$103	77,460
14	40.4	Iraq	\$17,900	\$249	223,508
15		Palestinian Territories	\$4,300	\$ N/A	N/A
16		Yemen	\$2,400	\$58	43,229





- Total Gross Domestic Product is \$3T
- Population is ~ 500,000,000
- Arabs constitute the largest ethnic group in the Middle East
- A few countries in the Middle East, such as Iran and Iraq, are majority Shi'a, but most others are majority Sunni
- Top six languages are English, Arabic, Persian, Turkish, Kurdish and Hebrew
- Several major religions have their origins in the Middle East, including Christianity, Judaism and Islam
- Unemployment is notably high in the Middle East, particularly among young people, a demographic representing 30% of the region's total population
- Many Middle Eastern countries are attempting to diversify their economies beyond oil







Risks





CORRUPTION PERCEPTIONS INDEX 2017

Despite the political changes that shook the Arab region six years ago, the hope for Arab countries to fight corruption and end impunity is moving slowly.



REGION AT A GLANCE:

HOW DO PEOPLE THINK CORRUPTION HAS CHANGED IN THE LAST 12 MONTHS?





CORRUPTION PERCEPTIONS INDEX 2017

The failure to fight corruption explains the sharp drop of most of Arab countries in the Corruption Perceptions Index 2016. 90 percent of these have scored below 50, which is a failing grade. The United Arab Emirates and Qatar have managed to remain above the average, in spite of their declined scores.

Middle East & North Africa: How many people think corruption has increased in the last year?

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CULTURES





Best Countries to do Business in the Middle East



- United Arab Emirates (Dubai, Abu Dhabi, etc.)
- Qatar
- Saudi Arabia
- Israel
- Kuwait
- Bahrain
- Oman
- Jordan
- Morocco
- Algeria

*Most Middle Eastern countries do not allow foreigners to have majority ownership of enterprises (so you must find a business partner who is a national to own at least 51% of your company.

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Who's spending & who's doing the design



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Who's Spending



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Who's Spending

- While petroleum remains lower than desired much of GDP spend is initiated by government sector but there are initiatives to reverse this trend
- 23% of public-private projects in Middle East 'abandoned' according to research by Middle East business intelligence service MEED due to poor deal structuring and higher than expected levels of risk

Cost of producing a barrel of oil and gas

Average cash cost to produce a barrel of oil or gas equivalent in 2016, based on data from March 2016.



Note: Brent crude price as of Feb. 22, 2018 at 4:25 p.m. BST. Source: Rystad Energy UCube

Who's Spending



"Finding a way to reconnect banks and firms is crucial to enhance growth opportunities in the region and international financial institutions have the expertise and willingness to complement domestic policies"

Debora Revoltella, the EIB Chief Economist.

Who is doing the design work

Sampling of local architects

- Terra Verde, Dubai
- Azhar Al Madina, Dubai
- Adgeco, Abu Dhabi
- Cracknell, UAE, London, Muscat
- Ecoscape, Dubai
- ICON, Abu Dhabi
- Verdaus Landscape Architects, Dubai
- Dar Al Handasa, Lebanon
- AISO, Lebanon

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Sampling of international architects

- Baharash Architecture
- HOK (Top award in 2015)
- Perkins & Will
- Gensler
- Foster & Partners
- Dabbagh Architects
- WKK Architects
- CRJA & Alliance with IBI Group

Types of projects

Dubai

Commercial

Abu Dhabi

Commercial and Municipal driven by the Emir

Oman

Municipal Projects primarily driven by the Sultan

Saudi Arabia

 Commercial and Municipal driven by the King & Prince

Turkey

• Commercial and Municipal





How do I relate?

- Limited education in irrigation so consultants often seek assistance
- Educating the customer is important in an effort to gain trust
- Government drives much of the projects personal relationships with government officials and local agents are key to success







Sustainability





The UAE Prepares to host **"The 2020 Most Sustainable World Expo"** event, it plans to transform itself into the most sustainable city in the world



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Sustainable Approach

Designers are shifting from a horticultural approach to an ecological one. An 85,000 sq. m Eco-Park for sustainable research and technology that will promote small and middle-sized enterprises is planned in Turkey.

Integrated water management in the Middle East leveraging storm water, grey/black water, potable water, processed water, etc.



Middle East Landscape Architecture Sustainability

UAE Sustainability Mission Statement:

The ultimate design intent for any sustainable project would be to minimize net water use by increasing efficiency and re-use, which can be achieved by:

- Recycling water and by encouraging the collection and re-use of rainwater to reduce the demand for potable fresh water
- Looking at highly efficient and smart irrigation systems and also storm water design
- Installing smart water efficient fittings, water meters and appliances
- Maintaining and improving the quality of ground and surface water
- Low-water use landscaping











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Dubai's Burj Al Arab Jumeirah Hotel by WKK Architects, UK



Palm Islands are three artificial islands, **Palm Jumeirah**, Deira Island and Palm Jebel Ali, on the coast of **Dubai**. Creation of the islands started in 2001. Key Landscape Architect: Cracknell



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Oman Date Palm, Ministry of Agriculture, Homoud Darwish Al-Hasani

The date palm cultivation occupies more than 83% of total fruit crop area in the Sultanate, which covers approximately 101,400 acres. Grown to Saudi Arabia, Qatar, Kuwait & Bahrain





Oman Date Palm, Ministry of Agriculture, Homoud Darwish Al-Hasani



King Abdullah Financial Center by SKIDMORE, OWINGS & MERRILL



Princess Nora Bint Abdulrahman University

Perkins+Will, in collaboration with Dar Al-Handasah (Shair and Partners)



King Faisal Saudi Hospital by Saudi Oger



Jefaira Development by 10 Design, adjacent to the Mediterranean on the Egyptian North Coast. "The master plan is designed to locate highly active spaces where the community will benefit most, thereby creating energized spaces and destinations

throughout Jefaira." – Paul Rodgers, Design Director at 10 DESIGN



NEOM – Saudi Crown Prince Mohammed bin Salman plans to build a new \$1T city on the Red Sea joining SA, Egypt & Jordan by multiple firms (33X the size of NYC). NEOM will run on 100% renewable energy.





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2022 World Cup in Qatar by Kiwi Architects in joint efforts with

Chris Glasson Landscape Architects/Thom Craig Architects



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Riyadh Palace, Saudi Arabia Project by AISO

Saudi Arabian Deputy Crown Prince Mohammed bin Salman has effectively ingratiated himself with the new U.S. administration by presenting himself as "a younger version of Trump"



\$20B mall with 1,200 shops, 5.5M square feet and *92M visitor per year*

Dubai's MiracleGarden

By Abdul Nasser Rahhal

90th Anniversary \$11M Mickey Mouse structure with 100,000 flowers & plants, weighing 35 tons

Best Practices for Success in the Middle East

RELATIONSHIPS ARE EVERYTHING

• Business people in the Middle East want to deal with people who they know and trust

MULTI-TIERED AND DIFFICULT TO BREAK IN TO

Don't be surprised if their contacts are a brother, uncle, or old family friend—this is a
good thing and this is the way things get done

FIND THE RIGHT COMPANIES TO REPRESENT

• Trust, but verify!

PREPARE FOR TOUGH NEGOTIATIONS

 Communication style and body language may determine your success or failure. Loud or rude behavior on your part is a sign of disrespect and will sour a deal

ENGAGE A MIDDLE EAST SPECIALIST

Like Rome, a Middle Eastern market presence will not be built in a day. You will require
patience as you build trust and connections within the local business communities.

Comments

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Or Equal Specification

How to Manage?

Steve Hohl

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Proprietary Specifications



- Project specifications commonly require a specific product.
- "Proprietary specifications require the contractor use only product manufactured by one company or describes a product that can only be supplied by one manufacturer.
- Occasionally, a spec will allow for an "or equal" product to be used...

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Reasons for Proprietary Specifications

- Substitution can incur liability
- Familiarity with product

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- Substitutions may not be exactly an "equal" with regard to hydraulics, electrical constraints, product features
- Matching existing standards or materials list

Typical Or Equal Requirements

- Proposed substitution be submitted 7-14 days prior to bid opening
- Notification on how product will impact completion
- Disclosure on cost implications

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- Detailed analysis of product performance
- Manufacturer literature, samples, reference projects
- Contractor to pay for design team review of product
- Written release of liability by owner / client
- Disclosure to other bidders

Public Contract Code

 "No agency of the state nor any political subdivision, municipal corporation, or district, nor any public officer or person charged with the letting of contracts for the construction, alteration, or repair of public works shall draft or cause to be drafted specifications for bids, in connection with the construction, alteration, or repair of public works, (1) in a manner that limits the bidding, directly or indirectly, to any one specific concern, or (2) calling for a designated material, product, thing, or service by specific brand or trade name unless the specification is followed by the words "or equal" so that bidders may furnish any equal material, product, thing, or service."

William C. Last, lfconstructlaw.com, 2015

Or Equal Experiences

- Product is not available
- Cost
- Contractor relationship with manufacturer
- Client owner influence by manufacturer
- New product release by manufacturer
- False promises





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Other Consultant Perspectives

• Flow rates

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- Pressure requirements
- Water windows
- Electrical constraints
- UL listing
- Durability
- Warranty
- Service





Key Points for Manufacturers

- Focus on educating specifiers on key performance criteria for consideration
- Expect tough questions and discussion
- If the answer is not known, say so.
- Tried and true recent installs, references, testimonials
- Expect products to be tested
- Don't confuse specifier resistance with responsibility
- Responsibility lies with the specifier. In the event of product failure, the owner will always call the specifier...







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Supreme Court ruling

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- Proprietary Specifications are not a violation of antitrust laws
- Trained professional specifiers make informed judgements on products which they think best serve their clients.
- Or equal only qualifies when the specifier waives specs or permits those manufacturers to bid.
- Responsibility is on manufacturers to educate the specifier about the product
- "The burden is on the supplier or manufacturer who has not been specified to convince the specifier that their product is equal for that particular product."

Whitten Corp. vs. Paddock, Inc. US District Court, Mass, the Federal First Circuit Court