Director’s Message

By Rhonda Pelton, ChemPID Director

Dear ISA Chemical and Petroleum Industries Division Member:

I would like to thank the ISA Chemical and Petroleum Division members and the ISA staff for the warm welcome and continuous support. I am grateful for the opportunity to serve and contribute to the goals and advancement of the Society.

In addition to the five strategic goals of the Society, (Content, Data, Coolest Delivery, Cybersecurity and Advocacy), 2016 ISA President, Jim Keaveney, has outlined several emphasis areas for this year. These emphasis areas are:

- Helping industry leaders as well as the public better recognize the value and benefits of automation.
- Accelerating ISA’s presence and successes internationally by addressing the unique needs and challenges within different parts of the world.
- Gaining continual feedback from its key stakeholders—members, leaders, partners, and end-user companies and professionals—to gauge progress and improve processes and solutions.
- Encouraging more members to seek leadership positions within the Society.

My predecessors Prabhu Soundarrajan and Matthew Conklin have laid a strong foundation for the Division. As one of the largest ISA Divisions, ChemPID, has a substantial impact in each of these emphasis areas.

Through your active engagement in ISA, we will continue to make our world a better place through automation. There are numerous ways that you can actively engage in Division activities, and impact your community:

- Submit an article or paper to be published in the Newsletter to ISAChemPID@gmail.com
- Join the discussion on LinkedIn ISA Chemical & Petroleum Division group
- Subscribe to ChemPID channel on Youtube ISA ChemPID
- Submit your work to be featured in a ChemPID Webinar ISAChemPID@gmail.com
- Present your work at ISA Events and Conferences
- Recommend a student for ChemPID ISA Technical Division Scholarship
- Serve as a volunteer for E-Week activities ISAChemPID@gmail.com

Our ChemPID board members have made the commitment to lead the way in making that impact. It is my pleasure to present to you the 2016 ChemPID Board that will join me in serving you and ISA during 2016.

DIRECTOR
Rhonda Pelton
Process Automation Manager
The Dow Chemical Company

PAST DIRECTOR
Matthew Conklin
DeltaV Technology Leader
Maverick Technologies

SECRETARY-TREASURER
Rolanda Reed
Senior Process Controls Engineer
Maverick Technologies

NEWSLETTER EDITOR
Rafia Noor
Automation Systems Engineer
Cyanco International, LLC

EDUCATION & SYMPOSIUM CHAIR
Fares Karadsheh
Account Manager/Project Development
Process Solutions

MEMBERSHIP CHAIR
Ashley Weckwerth
Instrumentation and Controls Department
Burns & McDonnell (Kansas City)
ChemPID Community Involvement and Recognition, 2015-2016

ChemPID Scholarship 2015 Recipients

Winner: Robert Robinson
Education Institute: Alvin Community College
Field of Study: Process Tech.

Winner: Grant Foster
Education Institute: Houston Community College
Field of Study: Process Tech, Mechanical Engineering

Winner: Rawan Allmallahi
Education Institute: University of Houston
Field of Study: Chemical Engineering

Winner: Zeshan Rizvi
Education Institute: Houston Community College
Field of Study: Chemical Engineering

Winner: Kale Van Ness
Education Institute: University of Houston
Field of Study: Chemical Engineering

Congratulations to our five outstanding recipients of ChemPID Scholarship, 2015.

ChemPID Member of the Year, 2015

The ISA Chemical and Petroleum Division recognizes Matthew Conklin as “Division Member of the Year for 2015” at the Industries and Sciences Honors & Awards Banquet, Louisville, KY on October 10, 2015. Matthew served as the ISA ChemPID Division Director from 2014-2015 and is highly recognized for his leadership, organizational, and technical skills within ISA.

E-week, 2016

ChemPID hosted an exciting E-Week (Engineers Week) activity online on February, 2016. ISA members and students were encouraged to build their own flow control system using house-hold items, and then required to test their designs. Due to the encouraging feedback, ChemPID plans to host another E-Week activity for 2017. Members and students will be given plenty of notice this year in order to plan ahead for this event. So, be on the look-out for the 2017 E-Week Flyer later this year from ChemPID!

Finally, ChemPID would like to thank all the sections that collaborated for this year’s E-Week effort. Many local sections sent the flyer out to their email list and gave positive feedback on ways to improve this activity for the future. ChemPID appreciates all of your effort for E-Week 2016!

ChemPID Collaboration with ISA Tar Heel Section, 2016

ChemPID former division director, Matthew Conklin presented an overview of DeltaV Distribution Control System at ISA Tar Heel Section hosted series on DCS Platforms.
ISA Calendar Events

62nd International Instrumentation Symposium (IIS) 2016
Saturday, 21 May - Thursday, 26 May, 2016
22 East Fifth St Dayton, OH 45402

2016 Modern Solutions Power Systems Conference (MSPSC)
Wednesday, June 8, 2016
The Drake Hotel, Chicago, IL USA

2016 Spring Leaders Meeting
Saturday, 11 Jun - Monday, 13 Jun, 2016
Marriott Raleigh Crabtree Valley, Raleigh, NC

Sensors Expo & Conference
Wednesday, 22 Jun 2016
McEnery Convention Center, San Jose, California USA

59th ISA POWID-EPRI Symposium
Monday, 27 Jun 2016 - Friday, 01 Jul 2016
1300 W Harris Blvd Charlotte, NC 28262

2016 ISA Water and Wastewater and Automatic Controls Symposium
Monday, 01 Aug - Thursday, 04 Aug, 2016
1850 Hotel Plaza Blvd Lake Buena Vista, FL 32830-8406

Best Calibration Practices: Interactive Workshop
Thursday, 18 Aug 2016
1601 NASA Road 1 Houston, TX 77058

Smart Automation 2016
Thursday, 01 September 2016 – Friday, 02 September 2016
KENYATTA INTERNATIONAL CONVENTION CENTRE, Nairobi, Kenya

Fall Leaders Meeting
Saturday, 24 Sep - Tuesday, 27 Sep, 2016
Newport Beach Marriott Hotel & Spa, Newport Beach, CA

Strategic Automation Leadership Conference
Wednesday, 12 Oct 2016
67 TW Alexander Dr, PO Box 12277 Research Triangle Park, NC 27709

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Visit:
isa.org/unemployedmembers
to learn more
Dual HCL (Hydrochloric Acid) Burner Operation Strategy in Chlor-Alkali Membrane Process

By Neelesh Shah, C.E.T., P.Eng., Sr. Instrumentation Engineer, Westlake Chemicals, nruneel@hotmail.com

BACKGROUND
In the Chlor-Alkali membrane process, hydrogen and chlorine gases are produced in the Electrolyzers. Typically, the Electrolyzers are made of an anode, cathode and membrane. The membrane is very sensitive to pressure fluctuations between Hydrogen and Chlorine gas headers. One of the most important process variables is differential pressure across the cathode and anode, which must be maintained at all times to maintain longer membrane life but more importantly, to avoid explosions due to process upsets.

Controlling the cell room pressure is very crucial.
The differential pressure across the membrane is maintained at approximately 8” W.C by means of differential pressure controller. The Hydrogen header pressure is typically controlled at about 120” W.C. while the Chlorine header pressure is controlled at 112” W.C. In cases of upset when the differential pressure across the membrane becomes too high or low pressure, the cell room will be shut down. Excessive chlorine pressure is avoided by relieving the gas to the waste gas dechlorination system or emergency vent scrubber (EVS) system. Similarly, a gas relief to the stack prevents excessive hydrogen pressure.

Typically, HCL synthesis unit is the end user in the Chlor-Alkali process and uses the chlorine and hydrogen gas produced in the Electrolyzer(s) to make hydrochloric acid. Generally, HCL synthesis unit has a requirement to maintain minimum feed header pressures on chlorine and hydrogen streams feeding the unit and is approximately 77-80” W.C on HCL unit.

Challenge
The startup or shutdown of the HCL burner unit(s) causes pressure disturbances in the header pressures that could cause an Electrolyzer trip in a matter of a few seconds. It is essential to control and maintain the pressure of Cl2/H2 headers to the burner unit(s) but also the differential pressure across Electrolyzers. The multiple burner operation increases the level of complexity tremendously.

Solution
The Flow Diversion concept is a way to minimize the pressure disturbance. By diverting the exact amount of gas being used by the burner(s) to some other destination (typically emergency vent scrubber (EVS) for chlorine and atmospheric vent stack for hydrogen gas), there would be little to no pressure disturbance in the header.

Basic Control Description
The basic strategy is to use the flow measurement of the gas to the burner and position a throttling control valve so that the flow through that partially open control valve would equal the flow to the burner and divert the excess gas to a safe area. The flow through the throttling valve would be prevented by a second up stream FC on-off valve. The on-off valve would be electrically connected to the burner safety shut-off valves, so that when the burner tripped and the safety shut-off valves closed, the on-off valve in the diversion line would open. After the flow was diverted the throttling valve would slowly close, giving the normal pressure control systems time to adjust to the new flow rates. Please refer to "TYPICAL CHLOR-ALKALI PLANT HEADER PRESSURE CONTROL SCHEME" which includes "BURNER DIVERSION SCHEME"

Detailed Control Description
The flow diversion control scheme includes one set of throttling control valves and an on/off valve for each chlorine and hydrogen service per HCL burner. The above strategy includes the example of dual HCL burners. As indicated earlier, HCL burner start up and shutdown modes are very critical and close attention needs to be paid during these modes.

1. **Burner startup mode**
   - Typically, HCL burner sequence includes following steps:
     I. Enable sequence
     II. Nitrogen(N2) purge
     III. Demineralized Water flow/ Air flow/ Recirculation acid flow establishment
     IV. Pilot Flame
     V. Main flame/ H2 flow ramping
     VI. Air flow replacement with Chlorine flow

Once the sequence is enabled, the hydrogen throttling valve will ramp open to its pre-set position and the on/off valve will remain in the open position since the safety shut-off valves are in closed position to the burner. This step will establish hydrogen flow from the header to the vent stack. This is the flow required during the main flame step for burner.

During the main flame step, the hydrogen safety shut-
off valves will open fully and the hydrogen flow control valve will open to the pre-set position to get the minimum required hydrogen flow to establish main flame. Upon opening the safety valves, the diversion on/off valve will be closed so the hydrogen flow will be diverted from the vent stack to the burner.

2. Burner shutdown/trip mode
During the normal operation of burner, the on/off valves on hydrogen and chlorine diversion lines remain in the closed position. However, the throttling valves will track the amount of hydrogen and chlorine flows and position their opening accordingly. This is achieved by the below math function and throttling valve vs the Cv characterizer, as defined below:

1. Math Function

The equation shown below incorporates the variables, Flow, dP (available pressure drop), P (upstream pressure), and the throttling valve's Cv value.

**CONTROL VALVE Cv VS FLOW EQUATION**

\[
C_v = \frac{F}{K \times SQ \ RT \ dP(P)}
\]

It is hoped that the pressure will remain steady enough that compensation for varying pressure and differential pressure will not be necessary. Initially, the math function should not incorporate pressure or differential pressure compensation. This makes the Cv vs Flow relationship much simpler. Using the flow used in the control valve sizing calculations and the resultant Cv will allow the determination of the “K” factor. The “K” factor can then be used to determine the throttling valve Cv for any Flow.

2. Throttling Valve Cv Characterizer

This characterizer is the throttling valve manufacturer's Cv vs valve position chart copied from their catalog. The input to the characterizer is from the math block calculated Cv and the output is the position that the valve should be at in % open. The “Output” will convert the % open to a 4 to 20 mA output.

**Why Automation isn't Process Control**

Products shaped by the needs of expedient automation may get us bitten by the wild process beast

By John Rezabek, process control specialist, ISP Corp
Published on Control Magazine, [www.ControlGlobal.com](http://www.ControlGlobal.com), August 2015

When exactly did the "a" in ISA change from "America" to "Automation"? It seems like 10 to 20 years ago our premier community for instrumentation and control began seeking a bigger, more inclusive tent that might expand the scope of membership and perhaps dissuade big-budget exhibitors from retreating back to their respective end-user groups. The big-spending end-user companies—primarily from large process industries like refining and petrochemical—became weary of sending their employees to what seemed like a week-long boondoggle, which was a perception not totally unfounded in reality. Attendees' propensity for food feasts, parties and swag was perhaps too big of a distraction from the biggest benefit of this community: furthering meaningful, useful and user-guided products and standards for process measurement and control systems.

In recent years, "upstream," the sector of our industry that explores, drills and delivers a vast variety of hydrocarbons, has come to the fore in the procurement of instrumentation and controls. When oil and gas prices were high, projects that stood between discovery and delivery couldn't be delivered fast enough, and while there may have been some deference to "low bidder," a lot of money was being spent. Most of the same products used in "downstream," such as control valves, pressure transmitters and control systems are employed in upstream, but I'd argue that the discipline as practiced leans more toward SCADA and "automation" than "process control."

What's the difference and why should we care? To me, the epitome of automation is a bottling line, where thousands of containers are cleaned, filled with a delicious beverage and capped at a dizzying pace that is marvelous to behold. Now I've performed the same thing manually—clean, fill, cap, put in a case—and the bottling line is pretty much doing exactly what I do manually. Every aspect of it can be precisely controlled because every aspect is precisely known, down to the beverage itself. There is "feedback" control in the servos that perform the various tasks, but they can be cranked up to blinding speeds because the motors and solenoids are engineered for a specific task. Because the things being "controlled" are engineered and manufactured, automation functions largely in an "open loop." It's just robotically doing a manual task, albeit in an amazing fashion. What distinguishes process control? In the process industries, we do our share of automation. How many motor-operated valves (MOVs) do you have? Every control valve "positioner" is a "servo." But whether you're manipulating a control
valve in a closed-loop PID scheme or manually turning a globe valve, chances are you’re interacting with a process, manipulating a flow, temperature, pressure or level that will have some effect on, for example, a distillation column or a chemical reaction. Boiling hydrocarbons and reacting chemicals may obey well-known properties of physics, but they’re rarely engineered or consistent enough to the extent one can rely solely on robotic automation.

Control systems and their human operators have to react to measurements in real time because processes obeying physics and physical chemistry are wild by nature. The molecules we’re tasked with herding through processes to produce a saleable product are mostly invisible. Unforeseen bad actors—co-products, contaminants or corrosive agents—show up all the time. While automation can do some amazing things, process control engineers are tasked with taming a wild beast.

When you’re in the ring with a lion, the importance of precise, timely and reliable information—“measurements” if you will—is tantamount to not being eaten. The whole science and mathematics of process control we learned in chemical engineering classes is predicated on the regular and relentless delivery of live, truthful process data. Processes are wild creatures by nature—we need to know, our control systems need to measure: where the beast is (now), and where do I need to move to remain whole?

"A" may stand for “automation” now, and automation is part of the infrastructure we deliver as process control professionals. ISA remains an entity that delivers useful and meaningful standards, such as safety instrumented systems, alarm management, network security and intelligent device management, for the process industries. However, products shaped by the needs of expedient automation may get us bitten by the wild process beast. Let’s hope our control systems suppliers ensure their core products aren’t diluted or compromised in the delivery of the relentless determinism required for process control.

Recommended Reading Material

Applying FOUNDATION Fieldbus
By B.R. Mehta and Y.J. Reddy

Applying FOUNDATION Fieldbus is a guide for the practitioners of process control systems. This book is aimed at providing the knowledge engineering and maintenance teams require. The technology benefits and areas for improvement are unbiased and from a user’s point of view, bridging the gap between theory and technician-level coverage on a practical basis. The book offers a pragmatic approach to the subject based on industrial experience, taking into account the latest technologies and professional practices. This book is an ideal introduction to the subject for junior-level professionals, as well as being an essential reference for more experienced practitioners.

For more information visit: https://www.isa.org/store/applying-foundation-fieldbus/43621642

Looking for a step-change increase in salaries

Results from the 2015 salary survey

By Rick Zabel, Managing Director, Publisher, and Occasional Editor of Automation.com

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Each year, InTech collaborates with Automation.com to conduct a salary survey. The results are in (yawn)! Let’s be honest; we work in a very conservative field. We do not accept or implement change very quickly. So why would we expect salaries to change much from year to year? Like previous years, the average salary of automation professionals increased only a modest amount—about 1.9% over last year.

Because not much changes year over year, I decided to take a look back at historical data. We have been conducting a salary survey fairly consistently over the past 11 years. We did not conduct the survey in 2006 or 2009, so there is a gap in the data for those years. You can see the trend line for the average U.S. salary of automation professionals in the bar chart.

Between 2005 and 2010, there was a relatively significant increase in the average salary. Over a five-year period the average salary increased by more than $22,400. That is a 29% increase, and certainly something to get excited about! Unfortunately, from 2010 to 2015 (the same length of time), the average salary only increased by about $8,000, an 8.1% increase.

Because one specific job function, automation/control engineering, represents exactly a third of our responses this year, I decided to look at that specific average salary trend also. It is no surprise that the trend in the engineering average salary chart matches very closely to the overall average salary trend.

U.S. automation/control engineer average salary by year

For more information visit: https://www.isa.org/store/applying-foundation-fieldbus/43621642
So, what happened in the past five years? Is the demand for automation professionals not as great? Is the value they bring to a company not as great? Was the cost-of-living increase not as great? I am fairly confident that the answer to all those questions is “no.”

For years, I have been preaching that automation professionals are underpaid considering the value they can (or could) bring to a company. Many facilities are operating on old technology and therefore are not reaping the true benefits of a fully integrated automation/business enterprise. More and more seasoned professionals are retiring, and we are not attracting enough new graduates into the automation field. What new grad wants to work for a company that is using 20–30 year-old technology?

The demand for automation professionals will remain high for the long term. As a result, salaries should continue to increase more quickly. I am looking for (and expecting) a step-change increase in salaries in the near future. My message to employers is this: It is time to make investments in new technology. It is time to enable your automation staff to add more value to your entire enterprise with those investments. It is time to act . . . now! If you do not make the investments, one or more of your competitors will. Your business growth and survival depend on it.

Salary determining factors

After years of conducting this salary survey, we have identified the five major factors that determine salary: geographic region, job function, level of education, industry segment, and years of experience.

Let’s dig into data. Our survey collected 3,330 responses from automation professionals around the world, with 71.1% from the U.S. Because salaries around the world vary greatly, we broke out the U.S. responses to avoid skewing results. All of the results quoted in this article, other than average salary by region of the world, represent U.S. responses only.

Snapshot of typical respondents

The job function of the typical survey respondent was an automation/control engineer, accounting for 33.3% of total responses. The most prominent “years of experience” category was 31 or more, indicated by 25.3% of respondents. More than half (51.8%) of the respondents were college graduates with a bachelor’s degree. Of respondents, 16.7% received an advanced degree, and 80.7% reported salary increases this year, with the largest percentage (36.2%) realizing a 3–4% increase.

The largest percentage of respondents (24.8%) reported a salary in the $100,000–$124,999 range. The second largest percentage (12.9%) reported a pay range of $125,000–$149,999.

Salary facts by region

The average salary in the U.S. is $107,383, up more than $2,000 from the previous year. The only other region that reported a higher average salary was Australia and New Zealand, which reported $108,602 (U.S. dollars). In the previous year, this region reported a significantly higher average salary of $134,709 (U.S. dollars). But, then the exchange rate was much closer to a 1:1 ratio. With the current exchange rate of 1.42, the stronger U.S. dollar accounts for the lower salary in that region this year.

Average salary by region of the world

<table>
<thead>
<tr>
<th>Region of the world</th>
<th>Average salary</th>
<th>Percent respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>$107,483</td>
<td>71.1</td>
</tr>
<tr>
<td>Canada</td>
<td>$105,717</td>
<td>6.8</td>
</tr>
<tr>
<td>Mexico</td>
<td>$37,500</td>
<td>1.0</td>
</tr>
<tr>
<td>Central America (including Caribbean)</td>
<td>$68,369</td>
<td>0.7</td>
</tr>
<tr>
<td>South America</td>
<td>$53,960</td>
<td>3.4</td>
</tr>
<tr>
<td>Europe (western)</td>
<td>$84,944</td>
<td>4.5</td>
</tr>
<tr>
<td>Europe (eastern)</td>
<td>$46,458</td>
<td>0.9</td>
</tr>
<tr>
<td>Africa</td>
<td>$59,095</td>
<td>1.5</td>
</tr>
<tr>
<td>Middle East</td>
<td>$85,349</td>
<td>3.0</td>
</tr>
<tr>
<td>Australia and New Zealand</td>
<td>$108,602</td>
<td>1.1</td>
</tr>
<tr>
<td>Asia and South Pacific</td>
<td>$50,163</td>
<td>3.7</td>
</tr>
<tr>
<td>South Asia</td>
<td>$37,985</td>
<td>2.3</td>
</tr>
</tbody>
</table>

Within the U.S., the highest paid region is the West South Central (South), with an average salary of $122,800, nearly identical to last year. The lowest paid region this year is the West North Central (Midwest), with an average salary of $95,571. (Regions are defined at Wikipedia.)

Average salary by region of the U.S.

<table>
<thead>
<tr>
<th>Region of the U.S.</th>
<th>Average salary</th>
<th>Percent respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>New England (Northwest)</td>
<td>$108,873</td>
<td>4.0</td>
</tr>
<tr>
<td>Mid-Atlantic (Northeast)</td>
<td>$103,497</td>
<td>9.2</td>
</tr>
<tr>
<td>East North Central (Midwest)</td>
<td>$101,754</td>
<td>17.2</td>
</tr>
</tbody>
</table>
It all depends on what you do

Your job function within the automation profession can come with a salary swing of more than $44,400. On the low end, those in maintenance and operations are earning $91,710 per year. On the high end, engineering management commands a $136,128 salary. The average salary of the largest percentage of respondents by job function (33.3%, automation/control engineering) was $106,629. The top five highest-paid job functions are:

- Engineering management: $136,128 (7.7% of respondents)
- Consulting engineering: $131,226 (4.8% of respondents)
- Project management: $121,264 (3.9% of respondents)
- Sales – business development: $119,486 (6.7% of respondents)
- General or operations management: $115,958 (5.3% of respondents)

Average salary by job function

<table>
<thead>
<tr>
<th>Job function</th>
<th>Average salary</th>
<th>Percent respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automation/control engineering</td>
<td>$106,629</td>
<td>4.0</td>
</tr>
<tr>
<td>Consulting engineering</td>
<td>$131,226</td>
<td>9.2</td>
</tr>
<tr>
<td>Design engineering</td>
<td>$102,688</td>
<td>17.2</td>
</tr>
<tr>
<td>Engineering management</td>
<td>$136,128</td>
<td>10.2</td>
</tr>
</tbody>
</table>

A degree of higher learning

Regarding education, 68.5% possessed a bachelor’s degree or higher. The average salary of college graduates (without further graduate school) is $111,333. Those respondents who either attended some graduate school or completed an advanced degree reported an average salary of $123,472—a $12,139 increase over college graduates. If you factor in that increase over your career, it certainly pays to get that advanced degree.

Average salary by highest level of education

<table>
<thead>
<tr>
<th>Level of education</th>
<th>Average salary</th>
<th>Percent respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>High school graduate</td>
<td>$94,239</td>
<td>3.1</td>
</tr>
<tr>
<td>Technical/trade school graduate</td>
<td>$92,386</td>
<td>15.6</td>
</tr>
<tr>
<td>Attended some college</td>
<td>$92,586</td>
<td>12.8</td>
</tr>
<tr>
<td>College graduate</td>
<td>$111,333</td>
<td>51.8</td>
</tr>
<tr>
<td>Graduate school/advanced degree</td>
<td>$123,472</td>
<td>16.7</td>
</tr>
</tbody>
</table>

Industry segment dictates pay

Not surprisingly, the biggest payer is the oil and gas industry segment at $125,772. The largest number of responses came from the engineering consulting or systems integration seg-

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<table>
<thead>
<tr>
<th>Region of the U.S.</th>
<th>Average salary</th>
<th>Percent respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>West North Central (Midwest)</td>
<td>$95,571</td>
<td>10.2</td>
</tr>
<tr>
<td>South Atlantic (South)</td>
<td>$103,115</td>
<td>14.2</td>
</tr>
<tr>
<td>East South Central (South)</td>
<td>$101,126</td>
<td>4.9</td>
</tr>
<tr>
<td>West South Central (South)</td>
<td>$122,800</td>
<td>21.3</td>
</tr>
<tr>
<td>Mountain (West)</td>
<td>$96,349</td>
<td>7.2</td>
</tr>
<tr>
<td>Pacific (West)</td>
<td>$113,596</td>
<td>11.9</td>
</tr>
</tbody>
</table>
ment (20.9%), where the average salary is $113,903.

### Average salary by industry segment

<table>
<thead>
<tr>
<th>Industry</th>
<th>Average salary</th>
<th>Percent respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemicals</td>
<td>$113,142</td>
<td>9.7</td>
</tr>
<tr>
<td>Engineering consulting or systems integration</td>
<td>$113,903</td>
<td>20.9</td>
</tr>
<tr>
<td>Food and beverage</td>
<td>$94,927</td>
<td>4.6</td>
</tr>
<tr>
<td>Industrial machinery and equipment</td>
<td>$102,408</td>
<td>10.9</td>
</tr>
<tr>
<td>Oil and gas</td>
<td>$125,772</td>
<td>14.0</td>
</tr>
<tr>
<td>Pharmaceuticals</td>
<td>$111,235</td>
<td>3.9</td>
</tr>
<tr>
<td>Utilities: electrical, natural gas, nuclear</td>
<td>$109,752</td>
<td>8.5</td>
</tr>
<tr>
<td>Utilities: Water and wastewater</td>
<td>$83,043</td>
<td>7.1</td>
</tr>
<tr>
<td>Other</td>
<td>$98,027</td>
<td>20.4</td>
</tr>
</tbody>
</table>

### With experience, comes more money

As you would expect, the average salary varies greatly by years of professional work experience. Based on the data, over the course of your career, you can expect to nearly double your salary. The salary of those with fewer than two years of experience is $60,217. Those respondents who put in 31 or more years are bringing home $119,842 per year.

### Average salary by years of experience

<table>
<thead>
<tr>
<th>Years of professional work experience</th>
<th>Average salary</th>
<th>Percent respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 years or fewer</td>
<td>$60,217</td>
<td>4.1</td>
</tr>
<tr>
<td>3–5 years</td>
<td>$74,330</td>
<td>5.6</td>
</tr>
<tr>
<td>6–10 years</td>
<td>$95,200</td>
<td>11.1</td>
</tr>
<tr>
<td>11–15 years</td>
<td>$103,529</td>
<td>9.8</td>
</tr>
<tr>
<td>16–20 years</td>
<td>$108,199</td>
<td>14.1</td>
</tr>
</tbody>
</table>

### What determines job satisfaction?

Over the years, the job satisfaction results never really changed. So we stopped asking. Job satisfaction within the automation profession is high. To refresh your memory, the feeling of accomplishment typically rated the highest. Technical challenge, benefits, salary, pleasant work environment, good relationship with work colleagues, and job security are also contributing factors. The top four most important benefits are health insurance, pension plan/401K, flexible working hours, and paid time off.

Again this year, we asked respondents to tell us if they are seeking other opportunities. Those who are actively seeking new opportunities made up 9.0% of respondents and had an average annual salary of $93,995—nearly $14,000 less than the average. Passive job seekers made up 39.7% of respondents, with an average salary of $103,900—nearly $3,500 less than average. Those not seeking new opportunities (51.3%) were making $112,627—more than $5,200 above the average salary.

### Licenses and certifications

We compared the salary of those with a professional engineering (PE) license to those without a license. It is no surprise that those with the license (14.3%) earned an average of $27,771 more each year, or an average salary of $131,958 versus $104,187 for those without the license (81.4%). What about those professional certifications? We asked respondents if they possessed any association certifications, and 28.6% had some kind of certification, while 68.9% did not. The salary did not vary much between the “haves” and “have nots.” Those professionals with a certification made $110,333, while those without made $107,037.

### Maximize your salary

As in previous years, I conclude the salary data with a recipe for how to maximize your salary. Like any great recipe, this recipe has not changed over the years:

- Get your BS degree (any engineering will do). An advanced degree will improve results.
- Move to the West South Central region of the U.S. (Ark., La., Okla., or Texas).
- Work in the oil and gas industry segment. If that does not work out, try engineering consulting or systems integration.
- Get your PE license.
- Exercise your leadership attributes and become an engineering manager.
• Continue to show your value to your managers and company. Convince them to make more investments in technology and business integration.
• Stick with your profession—you can almost double your salary throughout your career.

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