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OTKRIVANJE PROPUŠTANJA CIJEVNIH ARMATURA ULTRAZVUČNIM DETEKTOROM

Sažetak

Otkrivanje cijevnih armatura koje propuštaju na procesnom postrojenju od velike je važnosti za ukupni rad procesnog postrojenja. Pored smanjenja ukupnih gubitaka medija kao materijalnih troškova, poboljšava se održavanje opreme, čime se ostvaruje pregled stanja i održavanje opreme, sigurniji rad procesnog postrojenja te smanjuje zagađivanje okoliša.

Podaci dobiveni iz BP- rafinerija pokazali su da gubici nastali propuštanjem samo plinovitih medija u rafinerijama na cijevnim armaturama iznose 100.000 - 200.000 $ godišnje.

Ultrazvučni detektor za otkrivanje propuštanja cijevnih armatura koristi se u Rafineriji nafte Sisak od 1999. godine. Koristi se uglavnom za cijevne armature na koje se sumnja da dobro zatvaraju. Pored toga koristi se za provjeru ispravnosti sumnjivih armatura prije remonta postrojenja, kako bi se na vrijeme mogli planirati radovi, vrste i količine potrebnih armatura za zamjenu u remontu. Uštede koje su ostvarene daleko premašuju nabavnu cijenu samog instrumenta, koja je bila 22.560 $.

1. Uvod

Cijevne armarure služe za potpuno ili djelomično zatvaranje cjevovoda, da bi se postigli određeni procesni, sigurnosni ili regulacijski zahtjevi. Često se u praksi koriste istodobno obadvije navedene funkcije. Prema namjeni dijele se na: zaporne, sigurnosne i regulacijske armature.

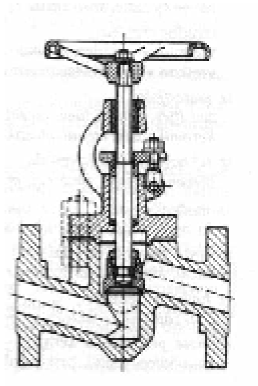
Zaporne i regulacijske armature u procesnoj industriji su izložene čestim zatvaranjima i otvaranjima, a time i riziku od onečišćenja sjedišta na koje u zatvorenom položaju naliježu njihovi pladnjevi. Kuglasti ventili izloženi su riziku onečišćenja teflonskih brtvenih površina ili pak deformaciji zbog termičkih naprezanja, dok kod sigurnosnih armatura stradavaju radne opruge (umor materijala) zbog izlaganja visokim tlakovima i visokim temperaturama. Sve to pridonosi činjenici da zaporne i sigurnosne armature nisu tijekom rada postrojenja uvijek u ispravnom stanju. Kada armature nisu u ispravnom stanju, dolazi do međusobnog miješanja različitih produkata, gubitaka u sustavu recirkulacije medija preko pumpi i kompresora ili istjecanje medija u okoliš. S obzirom na veliki broj armatura na glavnim i obilaznim (bypasses) vodovima uglavnom nije moguće na brzinu locirati koja od armatura propušta a koja dobro zatvara, što uzrokuje često smanjenje kvalitete produkata ili gubitke u neželjnom smjeru kao što je gubitak u vodu baklje ili propuštanje na postrojenju.

2. Cijevne armature

2.1. Zaporne armature

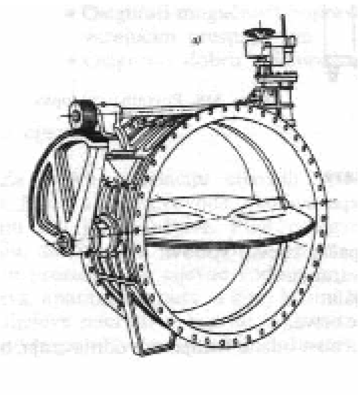
Zaporne armature u industriji kao i svakodnevnom životu služe za ograničenje ili zaustavljanje protoka medija (tekućina, plinova, para itd.) kroz cijevi ili otvore prema zahtjevima postrojenja. Njihovo posluživanje može biti ručno i automatsko. Razlikuju se prema smjeru gibanja samog zapornog mehanizma i djele se na četiri osnovne vrste: ventili, priklopci, zasuni, i slavine.

Ventili, slika 1, zbog jednostavnosti i lakoće rukovanja najviše su zastupljeni u primjeni zapornih armatura. Velikih su dimenzija u odnosu na promjer cjevovoda. Njihov zaporni mehanizam kreće se okomito na ravninu sjedišta pladnjeva bez klizanja u smjeru toka strujanja ili suprotno toku medija. Odižu se sa sjedišta, a zbog promjene smjera kretanja stvaraju velike otpore u strujanju medija. Zbog toga se kod otvaranja i zatvaranja armatura pojavljuju jaki udari pokretnih masa u cjevovodima. Kod najnovijih konstrukcija ventila ovi nedostaci su ublaženi, a kod nekih tipova gotovo potpuno uklonjeni. Koriste se za najviše tlakove, ali za srednje nazivne promjere.



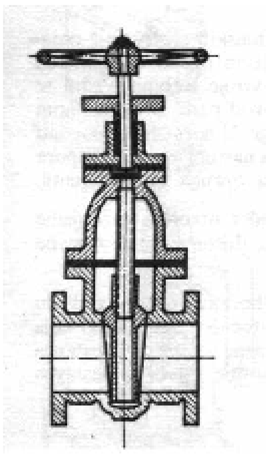
Slika 1. Ventil

Priklopci (zaklopci), slika 2, zaporne su armature s vrlo jednostavnom konstrukcijom, čiji se zaporni mehanizam kreće oko učvršćene osi po sjedištu bez klizanja. Otvarajući prolaz mediju ne izazivaju znatnu promjenu smjera kretanja i otpor strujanju. Primjenjuju se u znatno manjoj mjeri i uglavnom u specifičnim zahtjevima postrojenja.



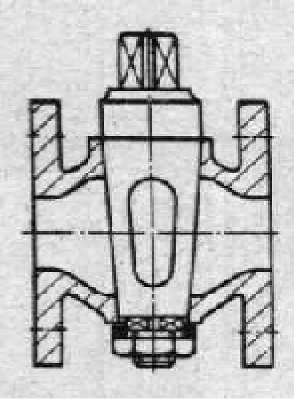
Slika 2. Zaklopka

Zasuni, slika 3, kreću se paralelno po sjedištu zapornog mehanizma uz klizanje i to okomito na smjer toka strujanja. Omogućuju neposredan i pun profil prolaza medija bez promjene pravca kretanja i gotovo bez povećavanja otpora strujanju. Kako bi se izbjegli udari pokretnih masa medija njihovo otvaranje i zatvaranje mora biti polagano. Znatno su kraći od ventila, ali im je zbog otvaranja potrebna velika ugradbena visina. Glavne mane su im komplicirana i tešta izrada, trošenje zapornih površina i velika sila potrebna za otvaranje i zatvaranje. Koriste se za najveće nazivne promjere i srednje tlakove.



Slika 3. Zasun

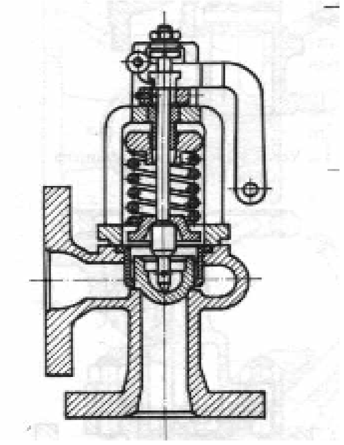
Slavine, slika 4, kreću se u sjedištu zapornog mehanizma uz klizanje i imaju otvor u svome pladnju koji omogućuje prolaz medija. Izrada im je jednostavna i jeftina, a koriste se za male presjeke cjevovoda. Osiguravaju puni profil prolaza medija bez skretanja. Mana im je što je za otvaranje i zatvaranje potrebna relativno velika sila, brzo se troše zaporne površine dosjeda i teško im je održavati nepropusnost.



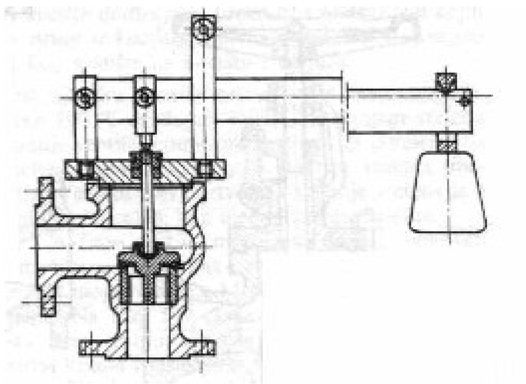
Slika 4. Slavina

2.2. Sigurnosne armature

Armature kojima se omogućava propuštanje povišenja iznad radnog tlaka u cjevovodima nazivamo sigurnosnim armaturama. Njihov zaporni mehanizam za vrijeme urednog odvijanja pogona je u zatvorenom položaju, a otvaraju se automatski kada tlak u vodu prijđe dopuštenu granicu. Na zaporne organe sigurnosnih armatura djeluje opruga, slika 5, ili uteg, slika 6, koji su proračunati za određene tlakove, a otvaranje će nastupiti tek onda kada tlak u vodu savlada silu proračunate opruge ili utega. Primjenjuju se radi zaštite od opasnosti prekoračenja dopuštenih tlakova u cjevovodima procesnih postrojenja.



Slika 5. Sigurnosni ventil s oprugom

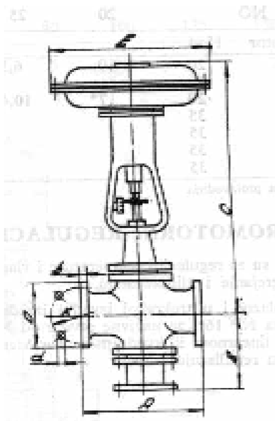


Slika 6. Sigurnosni ventil s utegom

2.3. Regulacijske armature

Armature čiji zaporni mehanizmi za protok medija mijenjaju položaj od otvorenog do zatvorenog nazivamo regulacijske armature. Koriste se za regulaciju protoka svih vrsta medija. Svaka regulacijska armatura već prema svojoj namjeni ima specifičan geometrijski oblik zapornog organa i sjedišta što određuje njezinu karakteristiku. Karakteristika regulacijske armature prema maksimalnom protoku i maksimalnom položaju otvorenosti može biti linearna, logaritamska i logaritamska s pomakom «nul točke». Pokretanje zapornog organa može biti pneumatsko, hidrauličko i elektromotorno.

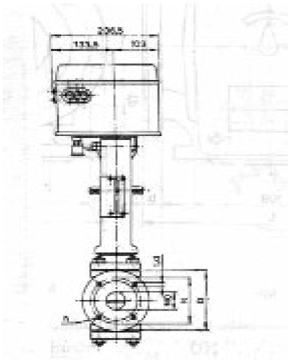
Pneumatski vođene regulacijske armature (slika 7) kao osnovni medij koriste instrumentacijski zrak, ali njegova stlačljivost nepovoljno utječe na brzinu i točnost regulacije (histereza). Signal se može prenijeti na udaljenosti od nekoliko stotina metara, a pneumatski vođene armature su sigurne, jeftine i dugog su životnog vijeka.



Slika 7. Peumatski regulacijski ventil

Hidraulički upavljane regulacijske armature manje se koriste zbog skupe razvodne mreže i hidrauličkih uređaja, te zapaljivosti konvencionalnih ulja. Ulje je nestlačivo a regulacija je brza i točna. Armature su neosjetljive na trešnju i udarce, a hidraulički upravljane regulacijske armature nalaze svoju primjenu u zrakoplovstvu i raketnoj industriji.

Elektromotorni pogon, slika 8, za upravljane regulacijske armature primjenjuje se uglavnom samo na postrojenjima gdje nema eksplozivnih atmosfera, zona 1 i 2, jer bi sigurnosne («S»-izvedbe) bile preskupe. Regulacijske armature električki upravljane djeluju brzo i precizno, a električni signal može se prenositi na velike daljine. Izravno je moguće u rad uključiti i procesna računala u svrhu vođenja procesa. Električni sklopovi omogućuju minijaturnu izvedbu i lako održavanje armature, ali su skupi.



Slika 8. Regulacijski ventil na elektromotorni pogon

3. Problematika cijevnih armatura (otvoreno-zatvoreno)

Ležišta zapornih organa cijevnih armatura u pravilu su najniže točke u unutrašnjem dijelu armature, a u otvorenom položaju izložena su taloženju svih vrsta onečišćenja i raznih krutih čestica. Prilikom zatvaranja armatura kada zaporni organi započnu nalijegati na svoja sjedišta, nataložene nečistoće sprječavaju njihov hod do krajnjeg položaja te oni više ili manje ostaju djelomično u otvorenom položaju. Kako takav položaj nije moguće vizualno prostim okom registrirati na cjevovodu, medij nekontrolirano najprije u malim količinama, a s vremenom sve više i više prolazi kroz takvu armaturu. Medij se ili miješa s drugim procesnim medijima, a kvaliteta produkata se narušava ili se gubi u slopovima, sustavima baklji ili istječe zagađujući okoliš. Ukoliko se radi o visokim tlakovima i temperaturama, ležišta pladnjeva stradavaju abrazijom materijala i takvu armaturu bit će potrebno vrlo brzo zamijeniti novom. Ako se radi o ključnoj armaturi procesa, onda njezina izmjena zahtijeva i obustavu čitave procesne sekcije, a ponekad i cijelog postrojenja.

4. Način rješavanja problema

Jedno od rješenja kako na vrijeme otkriti stanje ispravnosti cijevnih armatura jest primjena ultrazvučnog detektora. Armature kao što su ventili, zasuni, plinski ventili i slavine kojima se često manipulira potrebno je redovito i sustavno pratiti u češćim i jednakim vremenskim razmacima kako bi se na vrijeme predvidjela i otkrila neispravnost i planiralo pogodno vrijeme zamjene s ispravnom. One armature s kojima se malo manipulira ili rijetko odrađuje automatsko vođenje kao što su to sigurnosne armature, dovoljno je pratiti u dužim vremenskim razmacima ili kada se opravdano sumnja u njihovu ispravnost. Svakako da bi prije početka remontnih radova bilo poželjno sve ili barem većinu cijevnih armatura s kojima se često manipulira ispitati ultrazvučnim detektorom čime bi se na vrijeme dobili podaci o broju armatura koje bi trebalo skinuti s cjevovoda i remontirati u radionicama.

5. Ultrazvučni detektor za propuštanje cijevnih armatura

5. 1. Osnovne karakteristike ultrazvučnog detektora

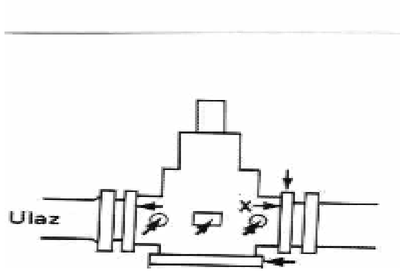
Metoda mjerenja ultrazvučnim detektorom omogućava brzo i djelotvorno utvrđivanje propuštanja svih vrsta medija kroz cijevne armature, kao i količinu propuštanja bez obzira na veličinu tlaka i do temperature koju propisuje proizvođač mjerne sonde. U cilju otkrivanja propuštanja određene armature, ona mora biti u zatvorenom položaju kako bi se postigla razlika tlakova na obje strane armature. Propuštanje medija kroz armaturu stvara strujanje koje izaziva zvučne efekte. Ultrazvučni detektor mjernom sondom mjeri visinu emisije toga zvuka, a uzimajući u obzir radne i konstruktivne parametre mjerene armature može se izračunati i količina propuštanja.

5.2. Postupak provođenja mjerenja propuštanja

Za kvalitetno mjerenje potrebno je odabrati na mjerenoj armaturi ravne i glatke površine po mogućnosti bez antikorozivnih premaza. Mjerne površine nužno je žičanom četkom ili strugačem očistiti od korozije i nečistoća te premazati pogodnim medijem za prijenos zvuka koji podnosi visoku temperaturu, npr. mast za podmazivanje, kako bi se kod mjerenja osiguralo što bolje nalijeganje mjerne sonde na površinu armature. U pripremljenu listu snimanja upišu se podaci o mjestu ugradnje, nazivu i tipu cijevne armature, dimenzije ulaza, namjeni armature i razlici tlakova na stranama mjerene armature. Mjerna mjesta koja se mjere na zapornim i regulacijskim armaturama su ulazna i izlazna prirubnica i ravne površine na donjoj strani ili bočnim stranama tijela armatura. Kod sigurnosnih armatura najbolje mjesto za mjerenje je ulazna prirubnica, slika 9.

Prije početka mjerenja potrebno je izmjeriti razinu šuma iz okoliša kako ne bi utjecala na točnost samog mjerenja armature. To znači da je svaki izmjereni signal veći od šuma potrebno oduzeti od ukupno izmjerenog signala na ispitivanoj armaturi kako bi se dobila visina signala propuštanja armature. Kod toga se smatra da visina efektivnog signala od 20dB jamči da je armatura ispravna i ne propušta medij.

Izmjereni podaci se upisuju u listu snimanja i pohranjuju u memoriju instrumenta, a nakon završenog mjerenja postoji mogućnost povezivanja s osobnim računalom i programom za obradu izmjerenih rezultata. Kod toga postoji opcija i ručnog unošenja izmjerenih podataka s liste snimanja.



Slika 9. Najbolja mjesta za mjerenje

5.3. Rezultati primjene

U Rafineriji nafte Sisak ultrazvučni detektor koristimo za višenamjenske poslove. Prvenstveno se koristi za otkrivanje propuštanja cijevnih armatura za koje se sumnja da dobro ne zatvaraju. Pored toga koristi se za provjeru ispravnosti sumnjivih armatura pred sam remont postrojenja, kako bi se na vrijeme mogli planirati radovi, vrste i količine potrebnih armatura za zamjenu u remontu. Bilo je slučajeva kada smo ga koristili za provjeru ispravnosti na armaturama kojima je bio demontiran samo zaporni mehanizam bez demontaže na prirubnicama, te je nakon čišćenja i sklapanja zapornog mehanizma iskorišten za provjeru ispravnosti iste armature.

Potrebno je napomenuti da tijekom provođenja kontrole nepropusnosti armatura nismo imali potrebe za mjerenjem regulacijskih armatura, jer one i onako gotovo nikada nisu u zatvorenom položaju, a ako i jesu onda ne moraju potpuno zatvarati. U dosadašnjem radu s ultrazvučnim detektorom raspolažemo velikim brojem mjerenih podataka na svim vrstama i tipovima zapornih i sigurnosnih cijevnih armatura, a za ovaj rad odabrali smo, sistemetizirali u tablicama i grafički obradili samo neke od njih (vidi prilog).

5.3.1. Ventil za plin – 1

U tablici 1 prikazani su rezultati mjerenja i praćenje stanja ispravnosti glavnog ventila za plin N_2 na postrojenju Merox, koji se samo povremeno otvara i zatvara. Kao što je iz mjerenih rezultata vidljivo, na ovom plinskom ventilu u vremenu praćenja nije bilo elemenata propuštanja.

5.3.2. Kuglasti ventil za plin – 2

Kao što se vidi iz tablice 2, pratili smo stanje plinskog kuglastog ventila za loživi plin na jednoj procesnoj peći, koji je izložen čestom zatvaranju i otvaranju. Može se primijetiti da je kod prvih šest zatvaranja i otvaranja ova armatura dobro zatvarala, ali kod sljedećih šest zatvaranja i otvaranja došlo je do oštećenja zapornih površina i armatura više nije zatvarala što je otkriveno kod šestog mjerenja. Kako nije postojala mogućnost gašenja procesne peći, ova armatura se koristila i dalje kao da je ispravna i doživjela još 11 zatvaranja i otvaranja. Na mjerenjima 6, 7 i 8 izmjereno je povećanje šuma signala i kod prvog gašenja procesne peći ova armatura je zamijenjena. Izmjerena je visina signala nove armature («nul stanje») i dalje se nastavilo pratiti stanje ove armature.

5.3.3. Sigurnosni ventil za plin – 4

Kod sigurnosnih ventila uglavnom nema čestog otvaranja i zatvaranja, a kada se otvore zbog prekoračenja tlaka, moraju se skidati i ponovno baždariti na sigurnosni tlak. Tada moraju zatvarati u potpunosti ili u protivnom nisu ispravni. Jedan takav sigurnosni ventil pratili smo na sekciji Merox plina, a rezultati su prikazani u tablici 3. Vidljivo je da su u prva četiri mjerenja izmjereni signali šuma bili stabilni. Kod petog mjerenja pokazala se povećana visina izmjerenog signala, ali još uvijek niže od granice propuštanja. To je ukazivalo na mogućnost otvaranja iste sigurnosne armature što se i potvrdilo za 34 dana kada je ova sigurnosna armatura propustila. Nakon skidanja i baždarenja ova sigurnosna armatura pokazala je nisku visinu signala. Međutim, već sljedeće mjerenje pokazalo je da se visina signala polako povećava, a kod novog mjerenja za cca mjesec dana visina signala ponovno se približila graničnoj vrijednosti propuštanja. Za otprilike 2 mjeseca ova sigurnosna armatura ponovno se otvorila.

5.3.4. Zasun za plin - 2

Ova zaporna armatura odabrana je namjerno za praćenje zbog problema visoke potrošnje dušika na postrojenju Aromati, koje nije u radu, a dušik služi za konzervaciju postrojenja. Radi se o glavnom zasunu dušika koji opskrbljuje postrojenje za proizvodnju aromata i koji se povremeno otvara i zatvara radi nadopunjavanja posuda koje moraju biti pod tlakom dušika. Kao što se iz tablice 4 vidi, početna mjerenja pokazala su nisku emisiju šuma, što je ukazivalo na potpunu ispravnost ove armature. Treće mjerenje je uslijedilo nakon dva otvaranja i zatvaranja, a izmjereno je naglo povećanje razine šuma i to do granične vrijednosti, ali još uvijek u području kada se smatra da armatura zatvara.

Za desetak dana mjerenje je ponovljeno i ustanovljeno je da armatura ne zatvara jer je razina šuma narasla na 40 dB. Kako se potrošnja dušika naglo povećala, nakon deset dana ponovili smo mjerenje ultrazvučnim detektorom i tada utvrdili razinu buke od 42 dB. Odlučeno je postojeću armaturu otvoriti i pregledati. Kod otvaranja zapornog mehanizma na sjedištu pladnja nađena je određena količina onečišćenja u obliku zrnate prašine. Pregledom zapornih površina pladnja i sjedišta nisu ustanovljena nikakva oštećenja te je armatura očišćena i sklopljena. Nakon puštanja pod tlak mjerenjem ultrazvučnim detektorom potvrđena je ispravnost ove armature, a izmjerena razina šuma iznosila 12 dB.

Prednost ovakve primjene ultrazvučnog detektora je od velikog značaja, jer je sačuvana vrlo skupa armatura, ostvarena ušteda je i na vremenu koje bi bilo potrošeno za njezinu zamjenu te je smanjena potrošnja dušika.

5.3.5. Ventil za tekućine - 6

Za ovaj tip zaporne armature pratili smo glavni ventil na usisu pumpe 3 za demineraliziranu vodu u Energani II. Kao što se vidi u tablici 5 ova zaporna armatura unatoč povremenom zatvaranju i otvaranju jako dobro zatvara, što se može pripisati vrlo čistom mediju.

5.3.6. Zasun za tekućine - 8

Ovaj tip zaporne armature na usisu pumpe 1 na dekarboniziranoj vodi tijekom praćenja ispravnosti pokazao je rezultate dobrog zatvaranja. Iako radi sa čistim medijem, na mjerenju 5, tablica 6, pokazala se nešto veća emisija šuma ali još uvijek u granicama kada armatura dobro zatvara, što bi se moglo pripisati nečistoćama u obliku metalnih čestica koje mogu nastati klizanjem zapornog organa zasuna po sjedištu. Već kod sljedećih mjerenja pokazalo se da je ta nečistoća odnesena medijem i armatura je jako dobro zatvarala.

5.3.7. Sigurnosni ventil za tekućine - 3

Kao i kod plinskih sigurnosnih armatura i sigurnosne armature za tekućine uglavnom su u zatvorenom položaju, a kada propuste, baždare se i ponovno služe svojoj svrsi. Sigurnosna armatura koju smo pratili na Meroxu benzina može se reći da je ukazivala na neispravnost najvjerojatnije zbog takozvanog umora materijala, iako je bio stabilan proces na sekciji bez promjena tlaka. To se može vidjeti iz prethodna četiri rezultata snimanja prije nego je propustila, tablica 7. To upućuje na činjenicu da se ovakvim radom može i predvidjeti kada će neku armaturu biti potrebno promijeniti, što je u procesnoj industriji od velike važnosti za smanjenje troškova proizvodnje.

6. Zaključci

Provedena kontrola mjerenja cijevnih armatura uporabom ultrazvučnog detektora u vremenu od 29.08.1999. do 08.01.2002. na postrojenjima u Rafineriji nafte Sisak je pokazala slijedeće:

1. Praćena je ispravnost na sedam vrsta cijevnih armatura za plinove i tekućine i to s raznim veličinama promjera.
2. Ultrazvučni detektor pogodan je za brzo otkrivanje ispravnosti cijevnih armatura kada se sumnja u njihovu ispravnost.
3. Preporuča se njegova primjena za sustavno praćenje ključnih armatura u procesu.
4. Podacima dobivenim mjerenjem ultrazvučnim detektorom omogućen je popravak zapornog mehanizma bez skidanja armature i zaustavljanja procesa.
5. Smanjenje troškova u procesu:
    - pravodobnim otkrivanjem propuštanja medija u procesu spriječeni su troškovi na gubicima loživog plina 12,55 t/g, benzina Meroxa 10,56 t/g i dušika 55,57 t/g,
    - smanjeni su troškovi skidanja i vraćanja armatura za vrijeme rada postrojenja, koji nastaju sanacijom oštećenih armatura što se sada može obavljati za vrijeme remonta.

   Vrijednost smanjenih troškova tijekom jedne godine daleko nadmašuje nabavnu vrijednost detektora koja je bila 22 560$.
6. Pravodobnim otkrivanjem propuštanja sigurnosnih armatura smanjena je emisija štetnih plinova u okolinu.

KONTROLNA LISTA STANJA VENTILA ZA PLIN

POGON: KP-6 **SEKCIJA: Merox**

Redni br.	Oznaka ispitane armature	Visina signala (dB)	Razlika tlakova (bar)	Dimen. ulaza(NB) (ins)	Zasun (da/ne)	Kugl. ventil (da/ne)	Veličina propuštanja (l/min)	Gustoća medija kg/m^3	Godišnji gubitak (t/god)	Broj predhodnih zatvar. i otvar.	Datum mjerenja
	1	2	3	4	5	6	7	8	9	10	11
1	GVN_2	12	4,0	1	n	n	0,3	1,25	0,19	?	29.8.00.
2	GVN_2	13	4,0	1	n	n	0,3	1,25	0,21	1	18.9.00.
3	GVN_2	13	4,0	1	n	n	0,3	1,25	0,21	0	10.10.00.
4	GVN_2	13	4,0	1	n	n	0,3	1,25	0,21	0	23.11.00.
5	GVN_2	13	4,0	1	n	n	0,3	1,25	0,21	0	16.1.01.
6	GVN_2	13	4,0	1	n	n	0,3	1,25	0,21	1	26.1.01.
7	GVN_2	16	4,0	1	n	n	0,4	1,25	0,29	2	27.2.01.
8	GVN_2	16	4,0	1	n	n	0,4	1,25	0,29	3	4.4.01.
9	GVN_2	16	4,0	1	n	n	0,4	1,25	0,29	2	11.5.01.
10	GVN_2	16	4,0	1	n	n	0,4	1,25	0,29	3	24.6.01.
11	GVN_2	16	4,0	1	n	n	0,4	1,25	0,29	1	03.8.01.
12	GVN_2	16	4,0	1	n	n	0,4	1,25	0,29	3	26.9.01.
										16	

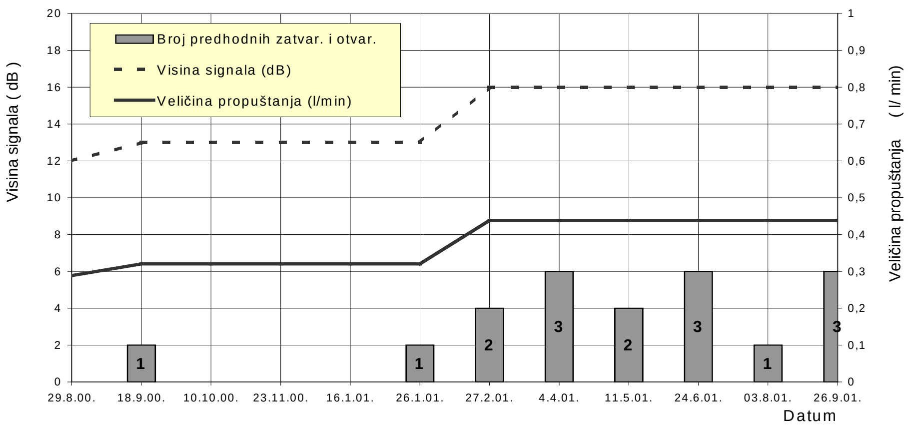
Napomena : Do 20 dB smatra se da armatura dobro drži.

Glavni ventil N_2 na sekciji Merox, koji se povremeno otvara i zatvara.

Mjerio: inž.B. Kocijančić

Gas valve: □ number of closing and opening;---signal intensity (dB), — leakage (l/min)

VENTIL ZA PLIN



KONTROLNA LISTA STANJA KUGLASTOG VENTILA ZA PLIN

POGON: KP-6 **SEKCIJA: Atmosferska destilacija**

Redni br.	**Oznaka ispitane armature**	**Visina signala (dB)**	**Razlika tlakova (bar)**	**Dimen. ulaza(NB) (ins)**	**Zasun (da/ne)**	**Kugl. ventil (da/ne)**	**Veličina propuštanja (l/min)**	**Gustoća medija kg/m^3**	**Godišnji gubitak (t/god)**	**Broj predhodnih zatvar. i otvar.**	**Datum mjerenja**
	1	2	3	4	5	6	7	8	9	10	11
1	PKV	6	1,0	2	n	d	0,2	0,2	0,02	0	26.2.01.
2	PKV	6	1,0	2	n	d	0,2	0,2	0,02	1	13.4.01.
3	PKV	12	1,0	2	n	d	0,4	0,2	0,05	4	22.05.01.
4	PKV	14	1,0	2	n	d	0,5	0,2	0,06	1	01.06.01.
5	PKV	18	1,0	2	n	d	0,8	1,2	0,52	6	28.06.01.
6	PKV	28	1,0	2	n	d	2,3	0,2	0,25	4	03.08.01.
7	PKV	52	1,0	2	n	d	28,7	0,2	3,01	6	21.09.01.
8	PKV	63	1,0	2	n	d	90,3	0,2	9,49	1	28.09.01.
9	PKV	10	1,0	2	n	d	0,4	0,2	0,04	0	03.12.01.
10	PKV	11	1,0	2	n	d	0,4	0,2	0,04	2	21.12.01.
11	PKV	13	1,0	2	n	d	0,5	1,2	0,31	0	27.12.01.
12											
										25	

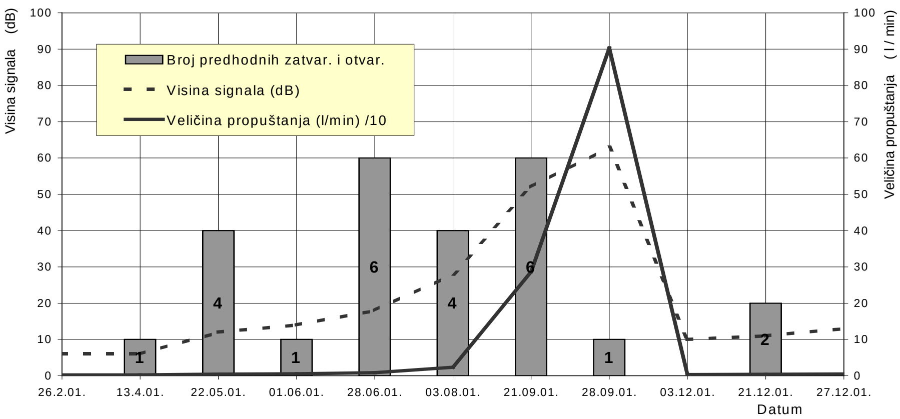
Napomena : Do 20 dB smatra se da armatura dobro drži.

Kugl ventil za plin na vodu loživog plina za gorionik procesne peći.

Mjerio: inž.B. Kocijančić

Gas ball valve: □ number of closing and opening;---signal intensity (dB), — leakage (l/min)

KUGLASTI VENTIL ZA PLIN



KONTROLNA LISTA STANJA SIGURNOSNIH VENTILA ZA PLIN

POGON: KP-6 **SEKCIJA: Merox**

Redni br.	Oznaka ispitane armature	Visina signala (dB)	Razlika tlakova (bar)	Dimen. ulaza(NB) (ins)	Zasun (da/ne)	Kugl. ventil (da/ne)	Veličina propuštanja (l/min)	Gustoća medija kg/m^3	Godišnji gubitak (t/god)	Broj predhodnih obustava	Datum mjerenja
	1	2	3	4	5	6	7	8	9	10	11
1	PSV-6602	12	6,0	4	n	n	0,9	0,614	0,30	?	10.8.00.
2	PSV-6602	12	6,0	4	n	n	0,9	0,614	0,30	0	5.9.00.
3	PSV-6602	12	6,0	4	n	n	0,9	0,614	0,30	0	23.11.00.
4	PSV-6602	14	6,0	4	n	n	1,2	0,614	0,37	0	20.12.00.
5	PSV-6602	19	6,0	4	n	n	2,0	0,614	0,63	0	7.2.01.
6	PSV-6602	41	6,0	4	n	n	19,4	0,614	6,25	1	26.2.01.
7	PSV-6602	11	6,0	4	n	n	0,8	0,614	0,27	0	27.2.01.
8	PSV-6602	16	6,0	4	n	n	1,4	0,614	0,46	0	21.3.01.
9	PSV-6602	18	6,0	4	n	n	1,8	0,614	0,57	0	26.4.01.
10	PSV-6602	32	6,0	4	n	n	7,6	0,614	2,45	1	28.06.01.
11	PSV-6602	12	6,0	4	n	n	0,9	0,614	0,30	0	29.06.01.
12	PSV-6602	15	6,0	4	n	n	1,3	0,614	0,42	0	7.8.01.
										2	

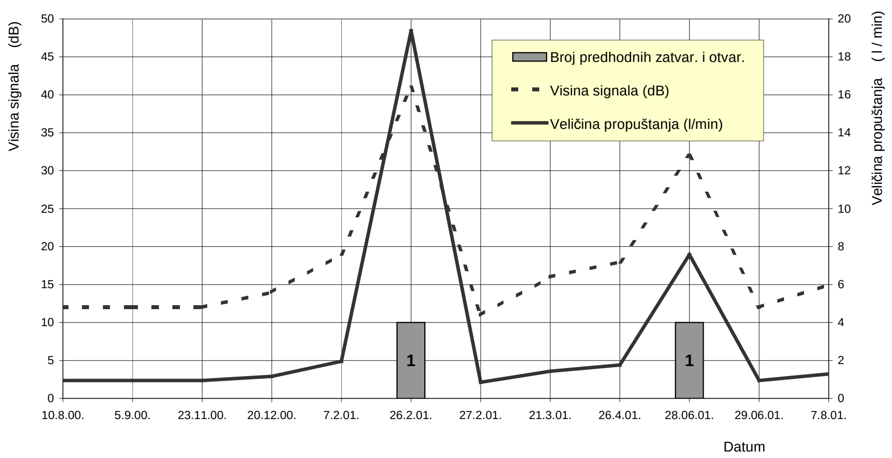
Napomena : Do 20 dB smatra se da armatura dobro drži.

Plinski sigurnosni ventil

Mjerio: inž.B. Kocijančić

Gas safety valve: □ number of closing and opening, --- signal intensity (dB), — leakage (l/min)

SIGURNOSNI VENTIL ZA PLIN



KONTROLNA LISTA STANJA ZASUNA ZA PLIN

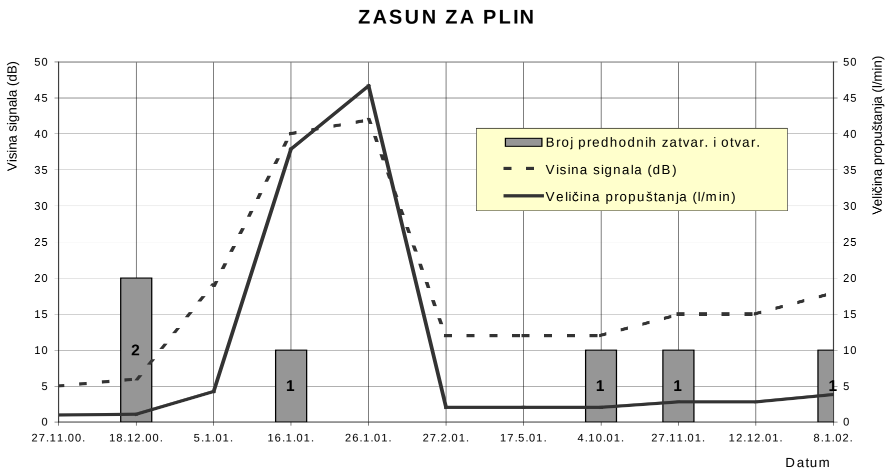
POGON:Aromati **PROC.SEKCIJA:**

Redni br.	Oznaka ispitane armature	Visina signala (dB)	Razlika tlakova (bar)	Dimen. ulaza(NB) (ins)	Zasun (da/ne)	Kugl. ventil (da/ne)	Veličina propuštanja (l/min)	Gustoća medija kg/m^3	Godišnji gubitak (t/god)	Broj predhodnih zatvar. i otvar.	Datum mjerenja
	1	2	3	4	5	6	7	8	9	10	11
1	BA-1	5	4,0	2	d	n	1,0	1,25	0,65	?	27.11.00.
2	BA-1	6	4,0	2	d	n	1,1	1,25	0,72	2	18.12.00.
3	BA-1	19	4,0	2	d	n	4,2	1,25	2,79	0	5.1.01.
4	BA-1	40	4,0	2	d	n	37,9	1,25	24,90	1	16.1.01.
5	BA-2	42	4,0	2	d	n	46,7	1,25	30,67	0	26.1.01.
6	BA-1	12	4,0	2	d	n	2,0	1,25	1,34	0	27.2.01.
7	BA-1	12	4,0	2	d	n	2,0	1,25	1,34	0	17.5.01.
8	BA-1	12	4,0	2	d	n	2,0	1,25	1,34	1	4.10.01.
9	BA-1	15	4,0	2	d	n	2,8	1,25	1,84	1	27.11.01.
10	BA-1	15	4,0	2	d	n	2,8	1,25	1,84	0	12.12.01.
11	BA-1	18	4,0	2	d	n	3,8	1,25	2,51	1	8.1.02.
12											
Napomena: **Do 20 dB smatra se da armatura dobro drži.**										6	

Glavna zaporna armatura dušika za Aromate koja je uglavnom zatvorena, a povremeno se otvara zbog nadopunjavanja posuda koje su pod tlakom dušika.

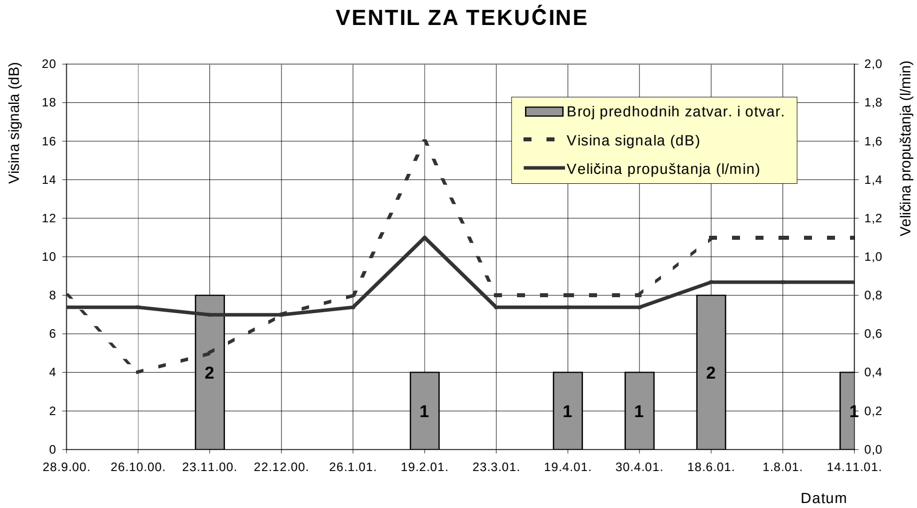
Mjerio: inž.B. Kocijančić

Gas valve: □ number of closing and opening, --- signal intensity (dB), — leakage (l/min)



KONTROLNA LISTA STANJA VENTILA ZA TEKUĆINE											
POGON:Energana							**PROC.SEKCIJA:Demineralizacija vode**				
Redni br.	**Oznaka ispitane armature**	**Visina signala (dB)**	**Razlika tlakova (bar)**	**Dimen. ulaza(NB) (ins)**	**Zasun (da/ne)**	**Kugl. ventil (da/ne)**	**Veličina propuštanja (l/min)**	**Gustoća medija kg/m^3**	**Godišnji gubitak (t/god)**	**Broj predhodnih zatvar. i otvar.**	**Datum mjerenja**
	1	2	3	4	5	6	7	8	9	10	11
1	GVP-3	8	6,0	6	d	n	0,7		0,000	?	28.09..00.
2	GVP-3	4	6,0	6	d	n	0,6		0,000	0	26.10..00.
3	GVP-3	5	6,0	6	d	n	0,6		0,000	2	23.11.01.
4	GVP-3	7	6,0	6	d	n	0,7		0,000	0	22.12..01.
5	GVP-3	8	6,0	6	d	n	0,7		0,000	0	26.01.01.
6	GVP-3	16	6,0	6	d	n	1,1		0,000	1	19.02.01.
7	GVP-3	8	6,0	6	d	n	0,7		0,000	0	23.03..01.
8	GVP-3	8	6,0	6	d	n	0,7		0,000	1	19.04.01.
9	GVP-3	8	6,0	6	d	n	0,7		0,000	1	30.04.01.
10	GVP-3	11	6,0	6	d	n	0,9		0,000	2	18.06.01.
11	GVP-3	11	6,0	6	d	n	0,9		0,000	0	01.08.02.
12	GVP-3	11	6,0	6	d	n	0,9		0,000	1	14.11.01.
Napomena: **Do 20 dB smatra se da armatura dobro drži.**										8	
Glavni zaporni ventil na usisu pumpe br.3.											
Mjerio: inž.B. Kocijančić											

Liquids valve: □ number of closing and opening, --- signal intensity (dB), — leakage (l/min)



KONTROLNA LISTA STANJA ZASUNA ZA TEKUĆINE

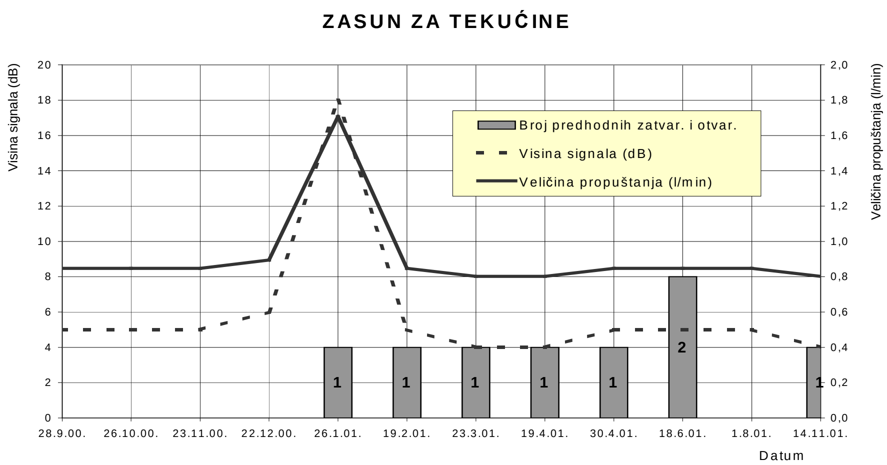
POGON:Energana **PROC.SEKCIJA:Dekarbonizacija vode**

Redni br.	Oznaka ispitane armature	Visina signala (dB)	Razlika tlakova (bar)	Dimen. ulaza(NB) (ins)	Zasun (da/ne)	Kugl. ventil (da/ne)	Veličina propuštanja (l/min)	Gustoća medija kg/m^3	Godišnji gubitak (t/god)	Broj predhodnih zatvar. i otvar.	Datum mjerenja
	1	2	3	4	5	6	7	8	9	10	11
1	GZP-1	5	4,0	8	d	n	0,8	1	0,445	?	28.09..00.
2	GZP-1	5	4,0	8	d	n	0,8	1	0,445	0	26.10..00.
3	GZP-1	5	4,0	8	d	n	0,8	1	0,445	0	23.11.01.
4	GZP-1	6	4,0	8	d	n	0,9	1	0,470	0	22.12..01.
5	GZP-1	18	4,0	8	d	n	1,7	1	0,898	1	26.01.01.
6	GZP-1	5	4,0	8	d	n	0,8	1	0,445	1	19.02.01.
7	GZP-1	4	4,0	8	d	n	0,8	1	0,422	1	23.03..01.
8	GZP-1	4	4,0	8	d	n	0,8	1	0,422	1	19.04.01.
9	GZP-1	5	4,0	8	d	n	0,8	1	0,445	1	30.04.01.
10	GZP-1	5	4,0	8	d	n	0,8	1	0,445	2	18.06.01.
11	GZP-1	5	4,0	8	d	n	0,8	1	0,445	0	01.08.02.
12	GZP-1	4	4,0	8	d	n	0,8	1	0,422	1	14.11.01.
Napomena: **Do 20 dB smatra se da armatura dobro drži.**										8	

Glavni zasun na usisu pumpe br.1.

Mjerio: inž.B. Kocijančić

Liquids gate valve: □ number of closing and opening, --- signal intensity (dB), — leakage (l/min)



KONTROLNA LISTA STANJA SIGURNOSNOG VENTILA ZA TEKUĆINE

POGON: KP-6 **PROC.SEKCIJA: Merox**

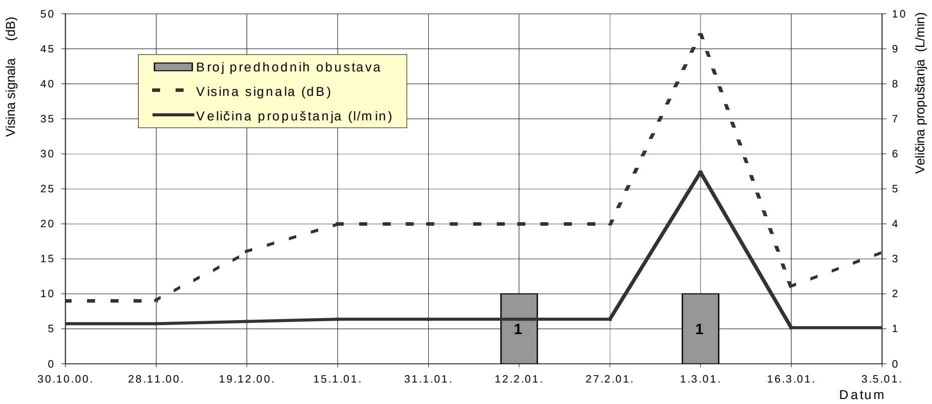
Redni br.	Oznaka ispitane armature	Visina signala (dB)	Razlika tlakova (bar)	Dimen. ulaza(NB) (ins)	Zasun (da/ne)	Kugl. ventil (da/ne)	Veličina propuštanja (l/min)	Gustoća medija kg/m^3	Godišnji gubitak (t/god)	Broj predhodnih zatvar. i otvar.	Datum mjerenja
	1	2	3	4	5	6	7	8	9	10	11
1	PSV-1	9	5,0	3	n	n	0,7	0,647	0,240	?	30.10.00.
2	PSV-1	9	5,0	3	n	n	0,7	0,647	0,240	0	28.11.00.
3	PSV-1	16	5,0	3	n	n	1,0	0,647	0,350	0	19.12.01.
4	PSV-1	20	5,0	3	n	n	1,3	0,647	0,434	0	15.01.01.
5	PSV-1	20	5,0	3	n	n	1,3	0,647	0,434	0	31.01.01.
6	PSV-1	20	5,0	3	n	n	1,3	0,647	0,434	1	12.02.01.
7	PSV-1	20	5,0	3	n	n	1,3	0,647	0,434	0	27.02.01.
8	PSV-1	47	5,0	3	n	n	5,5	0,647	1,861	1	01.03.01.
9	PSV-1	11	5,0	3	n	n	0,8	0,647	0,267	0	16.03.01.
10	PSV-1	16	5,0	3	n	n	1,0	0,647	0,350	0	03.05.01.
11											
12											
Napomena: **Do 20 dB smatra se da armatura dobro drži.**										2	

Sigurnosna aramatura na Merox-u benzina.

Mjerio: inž.B. Kocijančić

Liquids safety valve: □ number of closing and opening, --- signal intensity (dB), — leakage (l/min)

SIGURNOSNI VENTIL ZA TEKUĆINE



VALVE LEAK DETECTION USING ACOUSTIC EMISSION DETECTOR

Abstract

Detecting the leaking valves in refineries and chemical plants, has great significance with production facilities as well as big influence on total costs. Besides total media loses reduction resulting in cost reduction, the preventive maintenance improves, bringing big number of tested valves as the elements increasing safety and reliability of the processing plants.

The results obtained by implemented valve leakage detection technique at BP operating sites, have shown that cost savings of $ 100.000 -200.000 per annum per site can be realised.

Acoustic emission detector model 5131 with D9203IS sensor is in use on the site of INA Rafinerija nafte Sisak since August, 1999. Monitoring system has been implemented to valves suspected on leakage during normal plant operation. The obtained results have been used as a very usefull information for planing maintenance shutdown, as well as man-power and spare parts. The savings realised by far outcome the purchase price of the very instrument amounting 22.560$.

1. Introduction

Valves are used for a complete or partial closure of piping systems, in order to meet certain process safety or regulation requirements. Often both of the said functions are simultaneously used in practice. With regard to their purpose, they are classified as: closing, safety and regulating valves.

Closing and regulating valves in process industry are exposed to frequent closings and openings, and hence also to the risk of polluting the seat on which their wedge-type disk lies in closed position. Ball valves are exposed to the risk of polluting the teflon gasket sealing surfaces or to deformation caused by thermal stress, while in the case of safety valves operating springs are harmed (material fatigue) due to exposure to high pressures and high temperatures. All this contributes to the fact that blocking and safety valves are not always in order during a plant's operation. When valves are not in order, various products become mixed with each other, there are losses in the media recirculation system through pumps and compressors, or medialeakage into the environment. Given the large number of valves on the main piping lines and bypasses, it is usually not possible to quickly establish which valve leaks and which seals well, often causing reduction in product quality or losses in unwanted directions, such as loss into the flare, discharge water or leakage at the plant.

2. Piping Valves

2.1. Valves

Valves in industry as well as in everyday life serve for limiting or stopping the flow of media (fluids, gases, vapour etc.) through the piping or openings, according to plant requirements. Their handling may be manual or automatic. They differ according to the movement direction of the bolt mechanism itself and are classified into four basic types: valves, lidsXX, barsXX, and taps.

Globe Valves, Figure 1, are - due to the simplicity and ease of handling, the most represented in the application of blocking valves. Their dimensions are large with regard to pipeline diameter. Their blocking mechanism moves vertically to the surface of globe seat, with no sliding, in the direction of stream flow or opposite to the media flow. They are lifted from the seat, and, due to the change in movement direction, they cause rather great resistance to media flow. That is why in valve opening and closing heavy impacts of mobile masses in pipelines occur. In the latest valve designs, these flaws have been reduced, and in some types nearly completely removed. They are used for the highest pressures, but for medium nominal diameters.

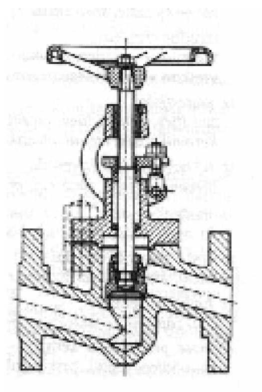


Figure 1. Globe Valve

Butterfly valves , Figure 2, are throttling valves with a very simple structure, whose closing mechanism moves around a tightened axis along the seat with no sliding. By opening passage to the media, they do not cause any major change in movement direction or flow resistance. They are applied to a much lesser extent, mostly for specific plant requirements.

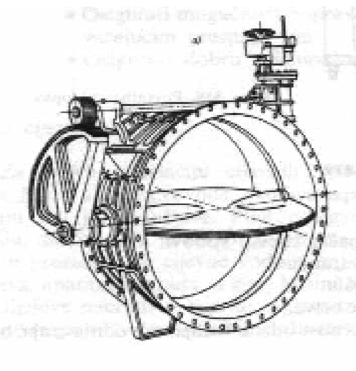


Figure 2. Butterfly valve

Gate valves, Figure 3, move paralelly along the activating screw seat with sliding, vertically to the stream flow direction. They enable an immediate and full media passage profile without changing the movement direction and practically without increasing resistance to flow. In order to avoid the impacts of mobile media masses, their opening and closing has to be slow. They are much shorter than valves, but – because of the opening – require a great installing height. Their main flaws are a complicated and difficult production, wear of sliding surfaces, and great force needed for opening and closing. They are used for the largest nominal diameters and medium pressures.

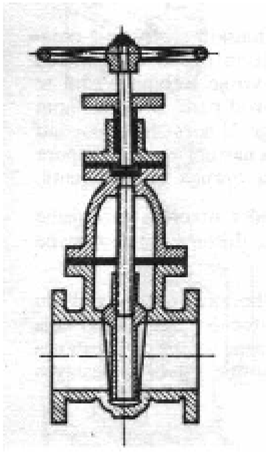


Figure 3. Gate valve

Taps or faucetts, Figure 4, move within the blocking mechanism seat with sliding and have an opening in their body enabling media passage. Their production is simple and cheap, and they are used for small piping diameters. They ensure a full medium passage profile without diversion. Their flaw is that they need a relatively great force for opening and closing, the sealing and contacting surfaces wear quickly, and are not easy to keep leakproof.

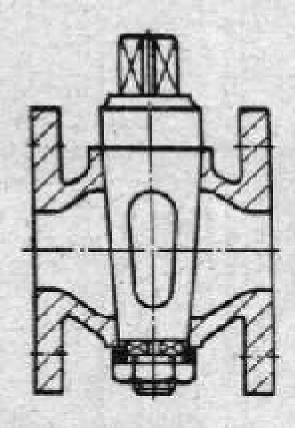


Figure 4. Tap

2.2. Safety Valves

The valves enabling the release of pressure above the operating one in pipes are called safety valves. Their blocking mechanism is closed during regular plant operation, and is automatically opened when the pressure in the tubing exceeds the permitted limit. The blocking elements of safety valves are acted upon by a spring, Figure 5, or a weight, Figure 6, being designed for defined pressures, while the opening will only occur when the pressure in the tubing overpowers the force of the predimensioned spring or weight. They are applied for protection against the danger of exceeding permissible pressure in the pipelines of process plants.

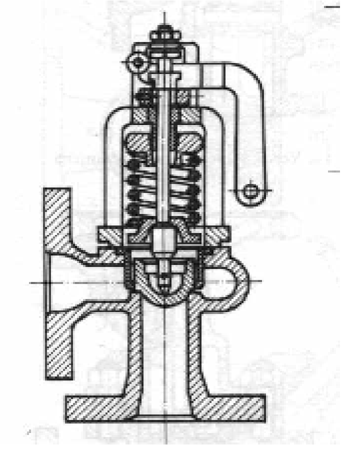


Figure 5. Safety valve with spring

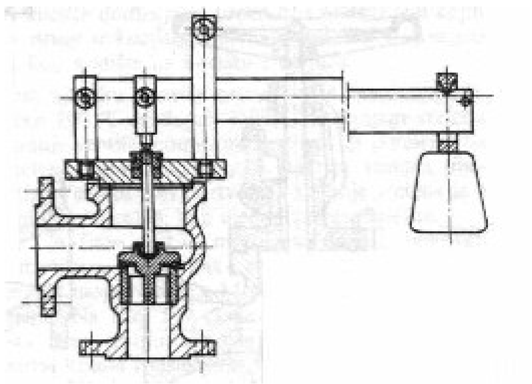


Figure 6. Safety valve with weight

2.3 Regulating Valves

The valves whose bolt mechanisms change position from opened to closed for media flow are called regulating valves. They are used for regulating the flow of all kinds of media. Each regulating valve, according to its purpose, has a specific geometrical form of the blocking element and seat, determining its characteristics. The characteristics of a regulating valve may – according to maximal flow and maximal position of openness - be linear, logarithmic and logarithmic with «zero point» shift. The bolt blocking element drive may be pneumatic, hydraulic and by electric motor.

Pneumatic, Figure7, activated regulating valves use instrumentation air as the basic medium, but its compressibility has a negative impact on the speed and accuracy of regulation (hysteresis). The signal may be transmitted to the distance of several hundred meters, while pneumatically guided valves are safe, cheap and have a long life span.

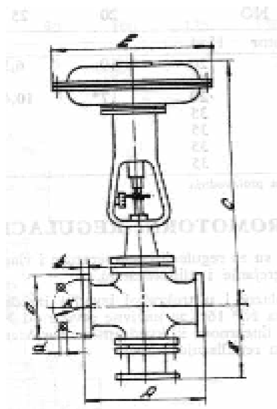


Figure 7. Pneumatic regulating valve

Hidraulically activated regulating valves are used less due to a costly distribution network and hydraulic devices, and flammability of conventional oils. Oil is not compressible, while the regulation is fast and accurate. The valves are not sensitive to shaking or impacts, while hydraulically guided regulating valves are applied in aircraft and rocket industry.

Electric motor drive, figure 8, is for guided regulating valves applied mostly only on plants where there are no explosive atmospheres, zone 1 and 2, because safety standards («S»-variants) would be too expensive. Regulating valves operated electrically are fast and accurate, while the electrical signal may be transmitted to large distances. Computers may be directly included for process control. Electric elements enable miniature design and easy valve maintenance, but they are costly.

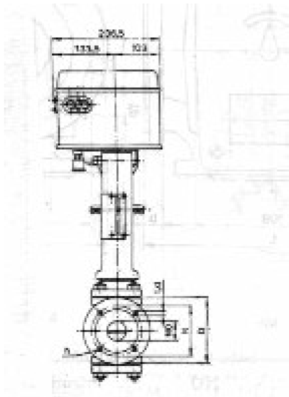


Figure 8. Regulating valve actuated by electric motor

3. The Problems Associated with Valves (open-closed state)

The valve seats of gate and globe valves are as a rule the lowest points in the interior part of the valve, while – in their open position – they are exposed to the deposition of all kinds of pollutants and various solid particles. During valve closure, when the wedge type disks begin to place themselves on their seats, the deposited impurities prevent their passage to the final position, which is why they mostly remain partially open. Since such a position cannot be detected with naked eye on the pipeline, the medium starts passing through such a valve without control, first in smaller, and later on in increasing volumes. The medium is either mixed with other process media, with the product quality consequently being impaired, or is lost in systems, or again leaks thus causing environmental pollution. If we are dealing with high pressures and temperatures, the plate seats are damaged through material abrasion, and such a valve will need to be replaced very soon by a new one. If it is a key process valve, its replacement requires the halt of the entire process section, and sometimes even of the entire plant.

4. The Problem Solution

One among the solutions for a timely detection of the correct state of valves is the application of an acoustic detector. Piping valves such as valves, bars, gas valves and taps, which are frequently handled, need to be monitored regularly and systematically in frequent and equal intervals in order to timely predict and detect any failure and determine the right moment for their replacement. The piping valves which are not frequently handled or are rarely automatically guided, such as safety valves, are sufficiently monitored over longer intervals or when there is reason to doubt their correctness. By all means, before any overhaul is started, it would be desirable to test all or at least most piping valves which are frequently handled using an acoustic emission detector, thus timely obtaining the data on the number of valves to be removed from the piping and repaired in workshops.

5. Acoustic Emission Detector for the Leakage of Valves

5. 1. The Basic Properties of Acoustic Emission Detector

The method of measuring using acoustic emission detector enables a fast and efficient detection of leakage of all kinds of media through piping valves, as well as volume of leakage regardless of pressure height and up to the temperature prescribed by the measurement probe manufacturer. For the purpose of detecting the leakage of a given valve, it has to be closed, in order to achieve pressure difference on both sides of the valve. Media leakage through the valve creates streaming causing sound effects. Using the measurement probe, the acoustic emission detector measures the sound's emission height, while, by taking into account the operating and structural parameters of the measured valve, one may also calculate the leakage volume.

5.2. The Leakage Measurement Procedure

A good quality measurement requires the selection of straight and smooth surfaces on the valve to be measured, preferably without anticorrosion coatings. The surfaces to be measured need to be cleaned of corrosion and all impurities using a wire brush or scrubber and coated by a favourable medium for sound transmission resistant to high temperature, such as, for instance, lubricating grease, in order to ensure a good adhesion of the measurement probe to the valve surface. Entered into the inspection file are the data on installation spot, name and type of the valve, input dimensions, valve purpose and pressure differential on both sides of the measured valve. The spots measured on blocking and regulating valves are the input and output flanges and flat surfaces on the bottom or lateral sides of the valve body. With safety valves, the best spot for measurement is the input flange, Figure 9. Before beginning the measurement, one must measure the level of environment background noise so that it does not effect the measurement accuracy. This means that every measured signal higher than background noise needs to be deducted from the measured signal on the tested valve in order to obtain the intensity of the valve leakage signal. It is considered that the effective signal intensity of 20dB guarantees that the valve is correct and does not leak the medium.

The measured data are entered into the file and stored into the instrument's memory, and once the measurement is completed it may be linked to a PC and the data processing software. There is also the option of a manual entry of data measured from the log.

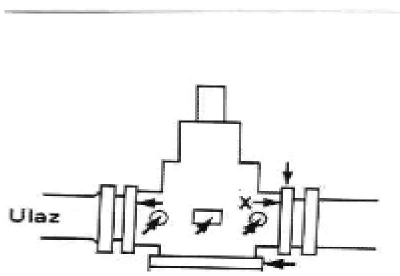


Figure 9. The best measurement spots

5.3. Application Results

At the Oil Refinery Sisak, acoustic detector is used for multipurpose tasks. It is primarily used for discovering the leakage of valves suspected not to seal well. It is also used for checking the functionallity of suspicious valves before the plant overhaul, in order to timely plan the operation, as well as the types and volumes of the valves to be replaced during the overhaul. There were cases when it was used for checking the correct state of valves with only the blocking mechanism dismantled, without flanges and was after the cleaning and assembly of the blocking mechanism used for checking the correctness of the same valve.

We must mention that while performing the control of valve impermeability there was no need to measure regulating valves, because they are almost never closed anyhow, and, even if they are, they do not need to seal. In our so far work with the acoustic detector we have collected numerous measurement data on all kinds and types of blocking and safety valves, some of which we have selected, systemized in tables and graphically processed (see supplement).

5.3.1. Gas Valve – 1

Table 1 shows the results of measuring and monitoring the correct state of the main gas valve N_2 on the Merox plant, which is being opened and closed only occasionally. As may be seen from the measurement results, this gas valve had no leakage during monitoring.

5.3.2. The Gas Ball-Valve – 2

As may be seen from Table 2, we have monitored the state of the gas roller valve for fuel gas on a process furnace, exposed to frequent opening and closing. We may observe that in the first six openings and closings the valve shot well, but in the next six openings and closings the blocking surfaces were damaged and the valve did not seal any more, as detected in the sixth measurement. Since the process furnace could not be switched off, the valve continued to be used as if it were correct and sustained another 11 openings and closings. Measurements 6, 7 and 8 showed an increased signal noise and after the first shutting off of the process furnace the valve was replaced. The new valve signal height was measured (the zero state) and the monitoring of the said valve continued.

5.3.3. Safety Gas Valve – 4

Safety valves usually do not involve frequent openings and closings, and, when they are opened due to excessive pressure, they must be removed and re-gauged to safety pressure. Then they have to seal or are not correct. One such safety valve was monitored on the Merox gas section, with the results being shown in table 3. It may be seen that in the first four measurements the measured noise signals were stable. The fifth measurement showed an increased measured signal intensity, but still below the leakage level. This pointed to the possibility of opening the same safety valve which was proven 34 days later when the said safety valve leaked. After removal and gauging, the safety valve showed a low signal level. However, already the next measurement showed that the signal intensity is slowly increasing, while during the new measurement in ca. a month's time the signal intensity once again came close to the limit leakage value. In approximately 2 months, the safety valve was opened again.

5.3.4. The Gas Gate-Valve - 2

This blocking valve was selected for monitoring on purpose due to the problem of a high nitrogen consumption at the Aromatics plant, which is not in operation, while nitrogen serves for plant conservation. It is the main nitrogen valve supplying the aromatics production plant occasionally opened and closed for the topping up of vessels which must be under nitrogen pressure. As may be seen from table 4, the initial measurements have shown a low noise emission, pointing to the valve's complete correctness. The next measurement followed after two openings and closings, with an abrupt noise level increase being detected, up to the limit value, but still within the area where the valve is considered to seal. In about a dozen days the measurement was repeated and the valve was found not to seal because the noise level went up to 40 dB.

Since nitrogen consumption abruptly increased, after ten days we repeated the measurement with acoustic detector and detected a 42 dB noise level. It was decided that the existing valve should be opened and inspected. During the opening of the blocking mechanism some impurities in the form of dust grains were found on disk seat. The inspection of the disk blocking surfaces and the seat did not reveal any damage, and the valve was cleaned and reassembled. After putting it under pressure, the measurement using an acoustic detector confirmed the valve's correct state, while the measured noise level was 12 dB. The advantage of this kind of acoustic detector application is considerable indeed, because a very costly valve was preserved, the time that would be needed for its replacement saved, and nitrogen consumption reduced.

5.3.5. The Fluid Valve - 6

For this type of blocking valve monitored was the main valve at the intake of pump 3 for demineralized water in Power-plant II. As may be seen from Table 5, this blocking valve seals well in spite of occasional opening and closing, owing to its highly clean medium.

5.3.6. The Fluid Gate-Valve - 8

This type of blocking valve at the suction of pump 1 on decarbonized water showed that it sealed well during correctness monitoring. Although operating with a clean medium, during measurement 5, Table 6, it showed a somewhat increased noise emission, but still within the limits where the valve seals well, which could be explained by impurities in the form of metal particles which could be generated by the sliding of the wedge type disk along the seat. Already the next measurements showed that the medium took away the impurities after which the valve sealed well.

5.3.7. The Fluid Safety Valve - 3

Same as in gas safety valves, fluid safety valves are also mostly closed, and, when they leak, they are gauged and return to their original purpose. The safety valve monitored on the gasoline Merox may be said to have revealed incorrectness probably due to the so called material fatigue, although the process at the section was stable with no pressure change. This may be seen from the previous four measurement results before it leaked, Table 7. This points to the fact that such work may even predict when a valve will need to be replaced, which is of a considerable importance in the process industry because of production costs reduction.

6. Conclusions

The measurement control of valves using acoustic detector performed from 29/08/1999 to 08/01/2002 at the plants of the Sisak Oil Refinery has shown the following:

1. Monitored was the correct state of seven types of valves for gases and fluids with different diameters.
2. The acoustic detector is good for a fast detection of the correct state of valves when there is reason to doubt it.
3. Its application is recommended for a systematic monitoring of «key valves» in the process.
4. The data obtained through measurement using an acoustic detector enables the repair of the blocking mechanism without valve removal or process halt.
5. Cost reduction of the process:
    - timely discovery of media leakage in the process prevented losses of 12.55 t/y of fuel gas, 10.56 t/y of Merox gasoline and 55.57 t/y of nitrogen,

- reduced were the costs of dismantling and assembling valves during plant's operation, generated by damaged valves repair, which may now be done during overhaul.

The value of reduced costs over a year by far exceeds the detector's purchase value amounting to US$ 22 560.

6. Timely discovery of the leakage of safety valves reduced the noxious gases environmental emission.

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